POWER PLANT ENGINEERING

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Power for the Toledo Machine and Tool Co.

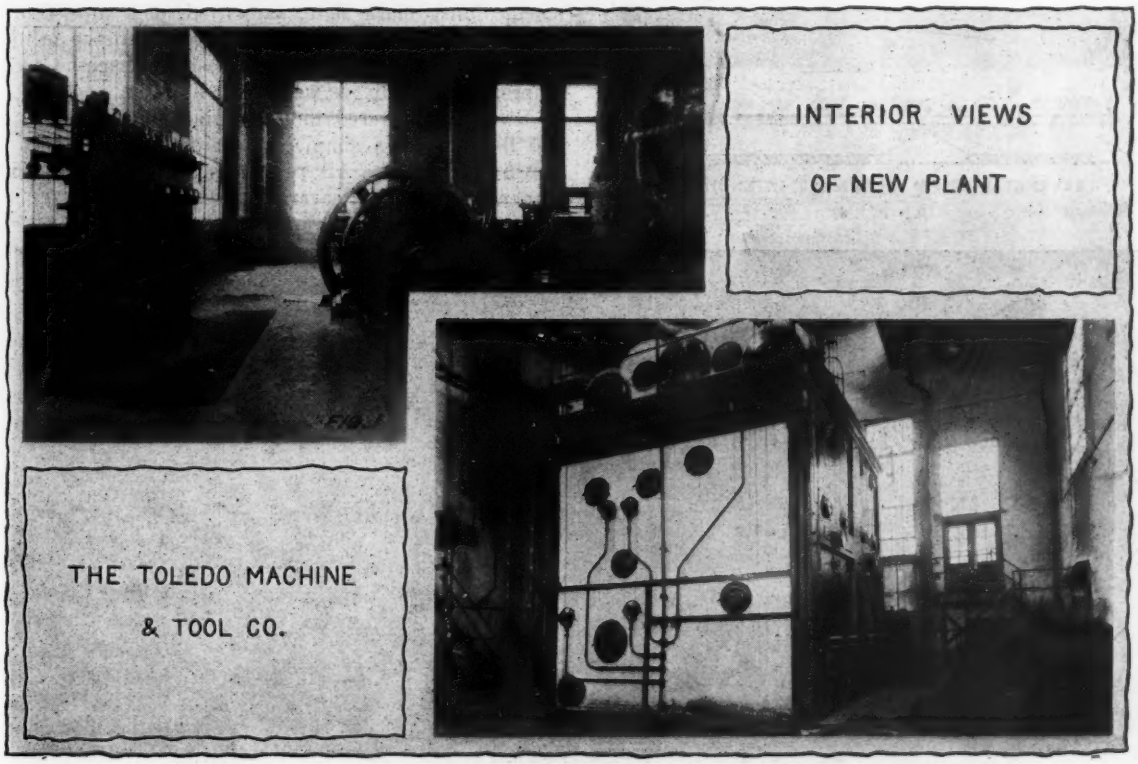
SUCCESSFUL CONVERSION OF HEATING PLANT INTO GENERATING PLANT INDUCES MANAGEMENT TO ERECT SEPARATE PLANT FOR NEW FOUNDRY

WHEN THE NATURAL GAS supply which had partially satisfied the power requirements of the Toledo Tool & Machine Co. at Toledo, Ohio, began to diminish a few years ago, the company was confronted by the problem of either erecting their own power plant, or of buying all their power from the local public service company.

They had already been purchasing considerable quantities of electric current, but had in addition operated two moderate sized natural gas engines which were located in the main machine shop. These now faced a permanent shut-down. The power plant proper, at that time consisted of a boiler plant, comprised of three boilers, totaling 555 hp., built for 150 lb. pressure. This plant was used merely for heating purposes.

Since the heating plant would have to be retained in any case, it was obvious that there were certain advantages to be secured by having a generating plant of their own, in fact, practically the only factor opposing the considerations favoring the construction of a new generating plant was that of initial investment. An investigation was conducted, however, with the result that finally the engine manufacturers who ultimately furnished the engines put forth a proposition to install the additional equipment necessary to convert the heating plant into an electric generating plant and to take half the cost of the new equipment in monthly payments, based on the saving the plant would effect against purchasing current.

This cost of current at that time was one cent per kw.-hr. with a demand charge of $1.25 per electrical



horsepower per month, based on their peak loads, all less a discount of five per cent. This was equivalent to a rate of approximately two cents per kilowatt-hour.

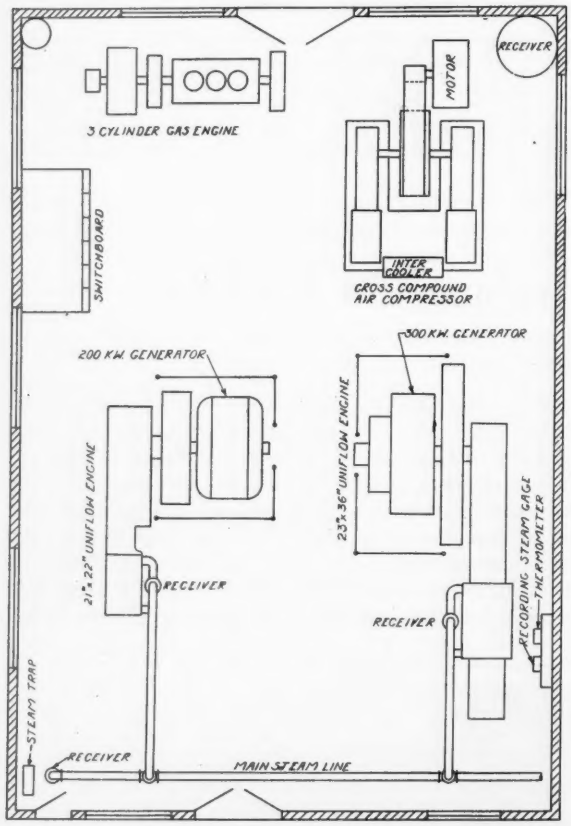


FIG. 3. ARRANGEMENT OF EQUIPMENT IN ENGINE ROOM OF OLD PLANT

The final outcome of the negotiations was that after three months of operation everything was found to be so satisfactory that the company paid cash for the uniflow engines. One of these units is shown in Fig. 4.

The existing boiler house was retained, but an addition was added to house the new generating equipment. This is a one-story building of brick and steel construction, and amply lighted on three sides by large windows. The arrangement is as shown in Fig. 3 and the equipment is enumerated as follows: One 23 by 36-in. uniflow engine, 180 r.p.m. 400 hp. direct connected to a 300-kw. 250-v. direct-current generator; one 21 by 22-in. uniflow engine, 200 r.p.m. direct connected to a 250-v. 800-amp. direct-current generator; one cross compound air compressor, belt driven by 100-hp. d.c. motor; one three-cylinder gas engine, direct connected to an 85-kw., 250-v. d.c. generator.

The gas engine generating set, although still occupying a place in the engine room is no longer used, not even for standby purposes. The air compressor supplies air at 100 lb. pressure, through an intercooler and aftercooler to a receiver located in the corner of the engine room. It is belt driven and due to the short distance between the motor pulley center and the drive wheel of the compressor an idler is provided to adjust the tension of the belt.

The control and distribution of electric energy is effected from a six-panel switchboard, constructed of marine finish black slate, supported on a pipe framework. All energy is distributed throughout the factory at 220 v. where it is used to operate machine tools, cranes, blowers, etc., as well as for lighting.

Steam is delivered to the engines at a pressure of 150 lb. through a simple system of steam headers as shown in Fig. 3. All piping is well insulated with 85 per cent magnesia covering.

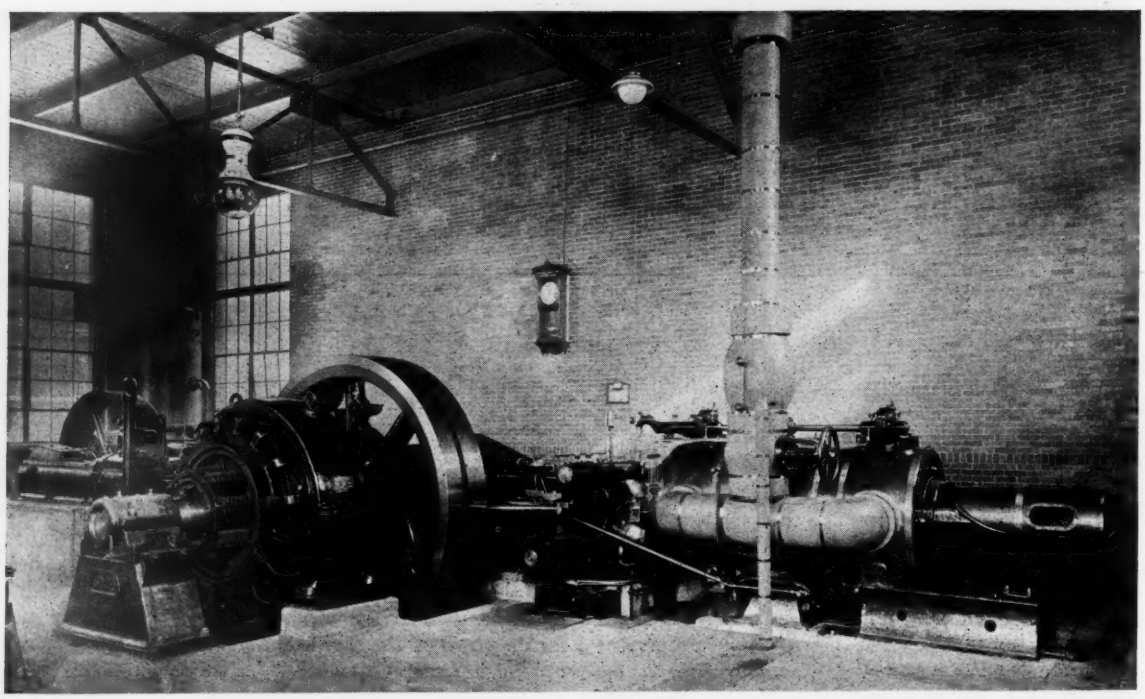


FIG. 4. ONE OF THE NEW GENERATING UNITS AT THE OLD PLANT

The engines are operated noncondensing since all exhaust steam is used for heating purposes. Compressed air is furnished to the shops at a pressure of 100 lb. for operating chipping hammers, etc.

The New Plant

Operating their own plant proved so successful that when it became necessary, early in 1920, to erect a new foundry about a mile away from the old plant, the company decided also to include a new power plant in the construction program.

This plant was completed in the fall of 1920 and consists of a boiler and engine room together with a coal storage pit, a pump house and water tower. All buildings including those belonging to the foundry group are constructed of brick and steel, and are amply lighted by large windows. An outside view of this plant is shown in Fig. 5.

This plant furnishes all the power, light and heat necessary for the operation of one of the largest foundries in the State of Ohio, and a large pattern shop.

Steam Generating Equipment

Steam is generated at a normal pressure of 150 lb. by two 250-hp. water-tube boilers, shown in Fig. 2. These boilers as may be seen are hand fired, and are equipped with balanced fire doors which prevent any possibility of accident caused by explosions in the furnace due to bursting tubes, etc. These doors are equipped with counterweights which permit them to open inward due to the force of the fireman's shovel, but causes them to close tightly when an increase of furnace pressure occurs.

Hand firing was selected due to the comparatively small size of the plant as well as the ease with which coal may be delivered to the boiler room.

Each boiler is fitted with two safety valves and equipped with automatic soot blowers.

FIG. 5. VIEW OF NEW POWER PLANT, SHOWING PUMP HOUSE AND WATER TOWER

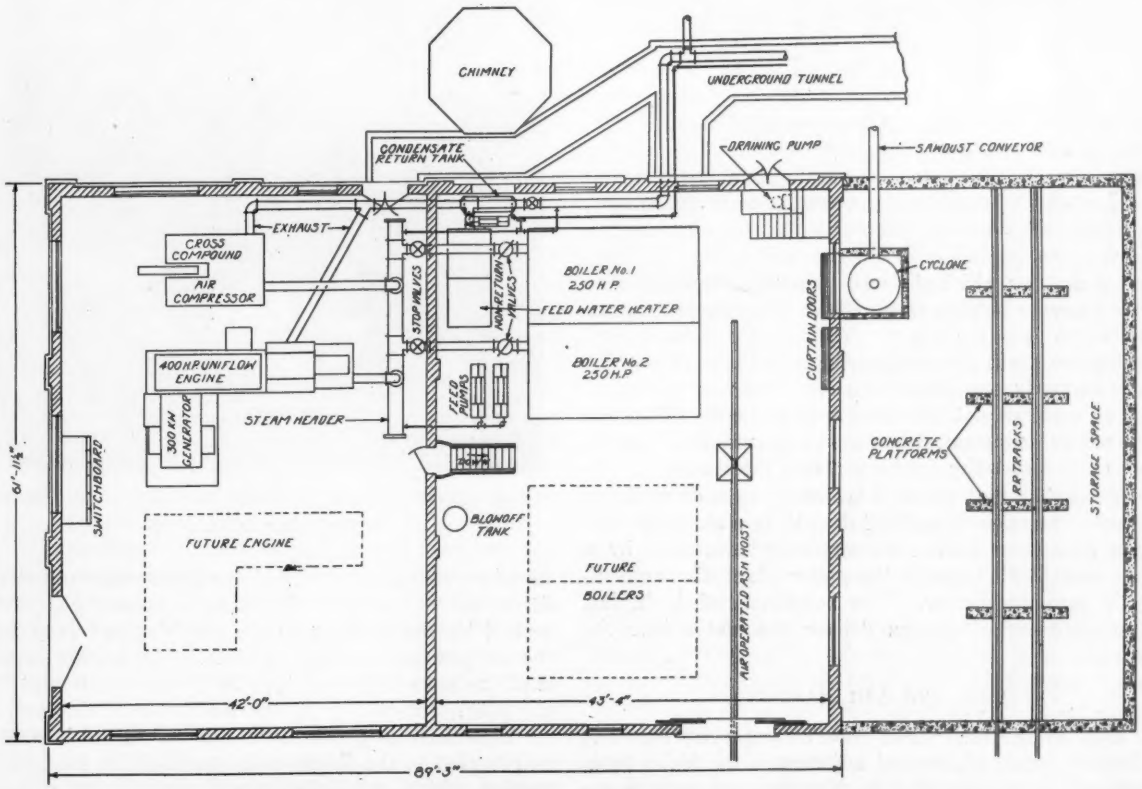


FIG. 6. PLAN SHOWING GENERAL LAYOUT OF NEW FOUNDRY POWER PLANT

.ıe products of combustion are removed by a 150-ft. .ıal brick stack which furnishes ample draft for .onomical operation. All boiler settings are exceptionally well built and are rendered airtight by coatings of sealing compound.

A blowoff tank is located in the boiler room as shown in Fig. 6. Boilers are blown down directly into this tank after which the water gravitates into another tank near the pattern shop. From the latter the water discharges into the sewer. This double blowoff tank arrangement was provided to eliminate difficulties which were formerly experienced due to the sewer tile cracking on account of high water temperatures. With the present arrangement, the water has sufficient time to cool off before being discharged into the sewer.

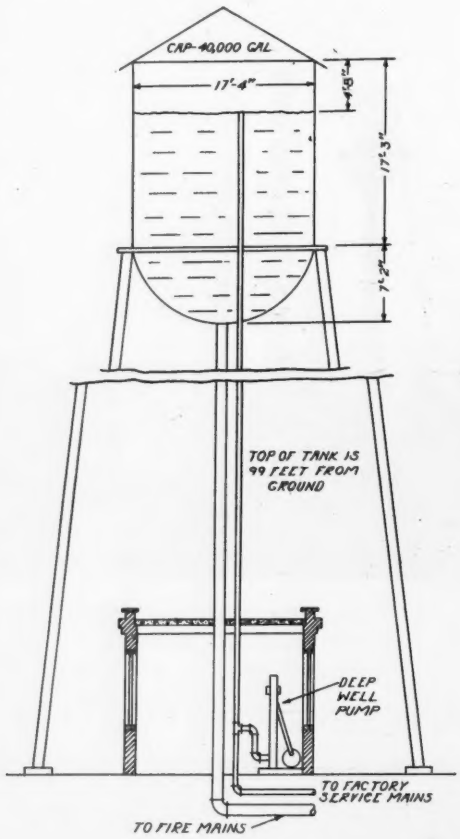


FIG. 7. SKETCH SHOWING ARRANGEMENT OF WATER SUPPLY PIPING

The boiler feed water is heated by exhaust steam to a normal temperature of 212 deg. F. in a sectional type open feed-water heater, automatically controlled by a float valve. All traps in the power plant discharge directly into this heater. Two hand controlled, duplex, direct-acting feed pumps deliver the water into the boilers.

Coal and Ash Handling

Coal is delivered direct from bottom dump cars into a large concrete pit located adjacent to the boiler room as shown in the plan Fig. 6. The cars run on a trestle supported by concrete piers in the pit and coal may be shoveled from the pit directly into the boiler room through doors provided for the purpose. One of these doors, equipped with a roll steel curtain, may be seen in the photograph, Fig. 2.

A sawdust conveyor from the pattern shop discharges into a cyclone located immediately outside of the boiler room. Sawdust from this cyclone drops into a specially constructed concrete bin from which it may be shoveled into the furnaces.

Ashes are handled by an air operated bucket conveyor, operating on an overhead trolley rail in the boiler room.

The Engine Room

The engine room is designed in accordance with the dictates of best modern practice and the apparatus is conveniently located. The interior walls are faced with a salt glazed brick while the floor is of concrete, finished with three coats of hardening compound.

The present equipment consists of one 400-hp. uniflow engine, direct connected to a 300-kw., 125/250-v. direct current generator, and one cross compound steam driven air compressor. The latter is automatically controlled by the pressure in the receiver, and maintains the air pressure constant at 95 lb. The uniflow engine is of the same make and type as the two engines at the old plant, referred to at the beginning of this article.

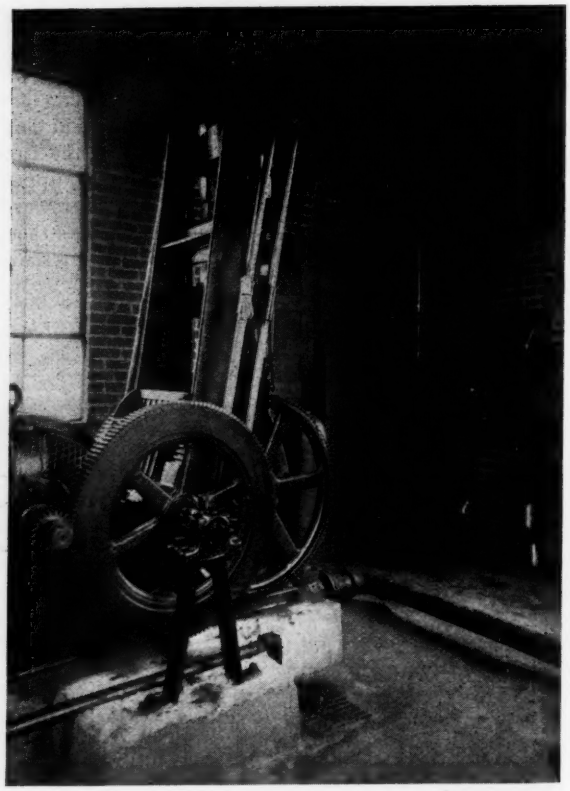


FIG. 8. INTERIOR VIEW OF PUMP HOUSE SHOWING MOTOR DRIVEN DEEP WELL PUMP

Electricity is generated at 220 v., but a balancing coil located in the basement is provided for use in connection with a three-wire system used for 110-v. lighting purposes. All current is controlled and distributed

from a five panel switchboard, consisting of one generator panel and four feeder panels.

Heating System

Except in cases of unusually cold weather, all heating is done by exhaust steam. Under normal conditions one pound pressure is carried on this building system. Condensate is returned to the boiler room through a common return line and empties into a tank near the feed-water heater which is fitted with a float, controlling a duplex pump. When the tank level rises, the water is automatically pumped into the feed heater.

All heating lines are well covered with magnesia insulation, and pass from the boiler room to the factory buildings through a concrete tunnel. This tunnel also carries the return lines and the electrical cables.

Pump House

An electrically operated deep well pump located in a pump house near the power plant pumps water into a 100-ft. water tower. This pump which is shown in the photograph, Fig. 8, has an 18-in. stroke and is operated by a 25-hp., 250-v., d.c. motor.

The purpose of the water tank is mainly to provide an adequate source of water supply under sufficient head to afford protection against fire. The deep well pump discharges into a vertical header the top of which feeds into the tank while the lower end connects with the factory service mains. This arrangement is shown in the sketch, Fig. 7. Since the object of the tank is to insure a reliable system of fire protection, it is obvious that some precautions must be taken to eliminate the possibility of draining the tank through the vertical header, should the pump stop. This is accomplished by extending the header through the bottom of the tank to a point 4 ft. 8 in. below the top of the tank. This prevents the water level from dropping below the level of the pipe opening and insures an adequate supply of water for fire extinguishing purposes at all times. The sprinkler system and fire mains are connected to a header which is fed from the lowest point in the storage tank.

Automatic Oil-Burning Plant at Sugar Refinery

Automatic Control in This Plant Makes Possible a Great Saving Over Hand Control. By Claude C. Brown

Following is a description of the oil-burning boiler plant of one of the western sugar refineries and is typical of the modern, up-to-date oil-burning installations in the West.

This plant, which was installed by Chas. C. Moore & Co., engineers, of San Francisco, Calif., consists of ten 600-hp. horizontal water tube boilers, equipped with economizers, together with all the automatic control apparatus necessary for the economical and efficient burning of oil.

The boiler plant is composed of the "New House" which contains the ten new 600-hp. boilers, and the "Old House," which contains four 275-hp. vertical water tube, four 250-hp. horizontal water tube and fourteen 175-hp. return-tubular boilers.

Two separate steam pressure systems are maintained at present; in the "New House" steam is generated at 150 lb. pressure for the purpose of operating three 1500 kw. noncondensing combination reaction and impulse horizontal turbo-generators. The surplus steam from this high-pressure header is stepped down through an automatically regulated butterfly valve, and is delivered through a crossover connection fully guarded with safety valves, to the 100-lb. header of the old house. The steam from this 100-lb. header after being reduced to 55 lb. pressure, is used almost entirely for the concentration of sugar solutions to the crystalline stage, in 14-ft. diameter vacuum pans.

The turbines are noncondensing, and discharge into exhaust steam system, the pressure of which is maintained at about 10 lb. The steam from this exhaust system is also used for the concentration of sugar solutions to the crystalline stage. In addition it is used for the heating of various liquors, syrups, etc., and supplies the necessary heat to operate a quintuple evaporator of approximately 15,000 sq. ft. of heating surface. It also heats over 1,000,000 gal. of water daily for refinery use.

The pressure on the exhaust steam system is maintained fairly uniform at 10 lb. per sq. in. by means of one of two 6-in. reducing valves which operate between the 150-lb. live steam header and the 10-lb. exhaust steam header. This valve opens when the exhaust pressure drops to 5 lb. and closes off when this pressure reaches 10 lb. If the exhaust pressure goes up to 15 lb., a multiport safety exhaust valve permits the excess exhaust steam to blow to atmosphere.

Fuel Oil

The fuel oil used in this plant is a California product of about 17 deg. Bé. gravity, and contains approximately 18,750 B.t.u. per lb. It is brought to the plant in barges; pumped from them into two steel storage tanks of 25,500 bbl. and 3780 bbl. capacity each. From these storage tanks it is pumped to four auxiliary concrete storage tanks, which are underground and adjacent to the boiler house. Two of these tanks are used for furnishing fuel oil to the plant, while the remaining two are being filled for stand-by storage. All tanks are equipped with steam smothering coils for use in case of fire.

From the auxiliary tanks the oil is drawn through strainers to two horizontal duplex steam pumps, size 9 by 8 by 10 in. of 80 gal. per min. capacity each; from here it is delivered to two special coil oil heaters, each having an internal heating surface of 600 sq. ft.

Each heater consists of 12 sections, each containing a coil of one-in. extra strong wrought iron pipe, in which the oil circulates from a 4-in. inlet to a 4-in. outlet header. Each coil is designed to withstand a pressure of 150 lb. per sq. in.

Within the section castings and around the coils, steam is circulated at exhaust pressure, 5 to 15 lb. per sq. in. The amount of steam admitted to these headers is varied so as to maintain the outlet oil at a temperature of 180 deg. F., which has been found to give the best results for combustion purposes.

From one of these heaters the oil is led directly to an oil header above the 22 boilers in the "Old House,"

and thence through drop lines to the oil burners of each boiler.

From the other heater the oil is led through an automatically controlled butterfly valve to the oil headers over the 10 boilers in the "New House."

The pressure of the oil at the burners is automatically controlled by a regulating system. This pressure is varied between 10 and 30 lb. per sq. in., according to the steam demands.

The oil burners used on all boilers are of the outside mixing, steam atomizing type. They are "rear shot"; that is, they extend the full length of the furnace, underneath the furnace floor, and rise into a small housing at the bridge wall; the burner head faces forward toward the boiler front, and the flame travels from the bridge wall forward.

This softener is a cold process apparatus, having a capacity of 27,000 gal. per hr., and a storage capacity of 17,000 gal. of treated water. It consists of a large redwood tank, 30 ft. 9 in. in diameter, by 19 ft. 4 in. high, into one side of which the water is led, together with its lime and soda treatment, where it is stirred or agitated. From here it passes down under a dividing partition, and comes up through an excelsior filter bed, to the outlet on the other side. From this point the treated water drops by gravity to a cistern underneath the boiler house.

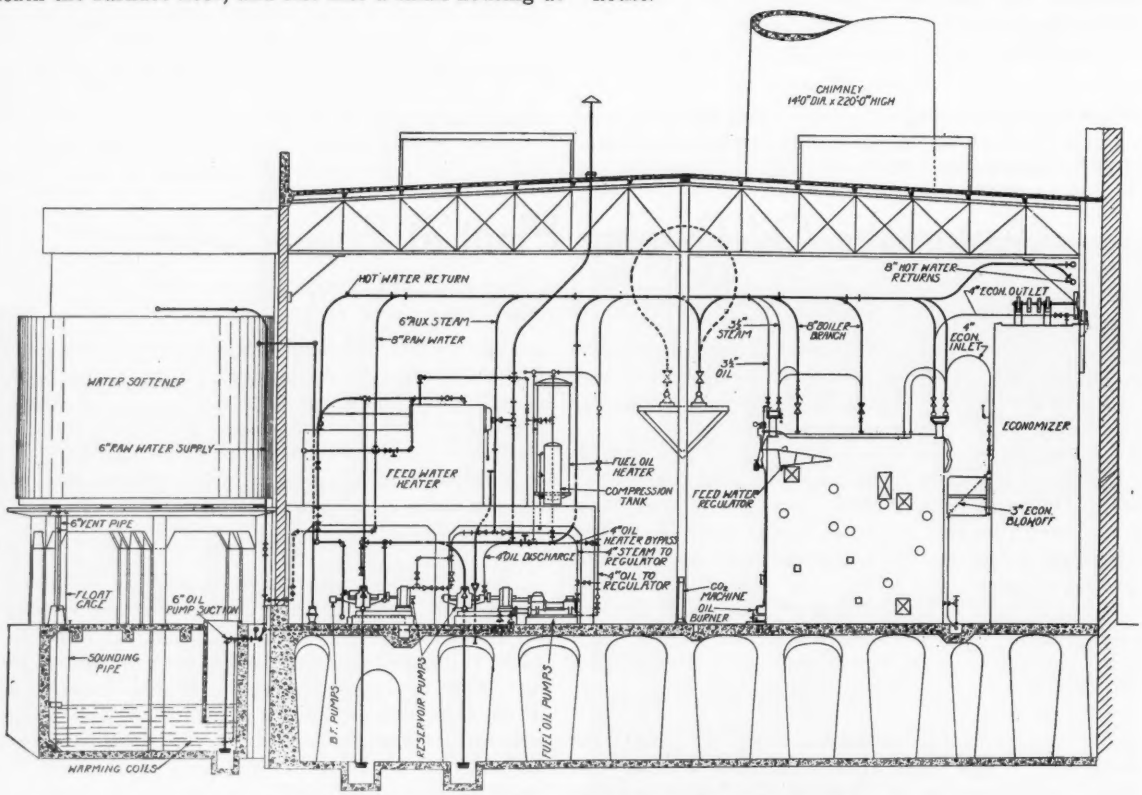


FIG. 1. SECTION THROUGH BOILER ROOM OF OIL FIRED PLANT

Feed Water

In the refining of sugar, much heating and boiling is done by means of steam coils immersed in the product to be boiled or heated. The return drips from these coils are led back to the boiler room by gravity, and into one of two open feed-water heaters, each having a capacity of 250,000 lb. of water per hour. These return drips constitute about one-half of the feed water evaporated. The remaining half is made up of treated river water, which is admitted to the heater at the steam inlet end. From the heaters, which are placed upon a raised concrete platform, the feed water drops straight down to one of two turbine feed pumps, which are located on the boiler room floor, underneath the heater platform.

The make-up water, which comes from the Sacramento River, is pumped to a softener, which is located just outside the boiler room, and over the auxiliary oil tanks.

In order to prevent the possibility of the turbine driven feed pumps running away after draining the heater dry, with the power off the motor driven centrifugal service pumps, there is installed an emergency duplex steam pump, size 7½ by 8½ by 10 in. with a capacity of 500 gal. per min. Should the water level in the heaters fall to 24 in. from the bottom, a float actuated valve opens up, releases the pressure on the discharge side of this pump, which in turn operates a governor, which admits steam to the pump, which delivers 500 gal. per min. from the cistern to the heaters.

From the bottom of the heaters a manifold delivers the water to one of two turbine feed pumps which feed the boilers of the "New House," and three reciprocating horizontal pumps that feed the old house. The turbine feed pumps have a 1000 g.p.m. capacity, against 462 ft. head, at 1800 r.p.m. Each pump is driven by a single-stage horizontal turbine running at 1800 r.p.m. with a horizontal throttle pressure of 140 lb. per sq. in., and an exhaust pressure of 15 lb. per sq. in.

The feed water, which is at an average temperature of 170 deg. F. is then pumped through a 10 by 4 in. Venturi meter, having a capacity of from 55,600 to 722,000 lb. of water per hour, and its rate and amount is recorded. Thence it goes, under approximately 190 lb. per sq. in. pressure to five economizers, each consisting of 32 sections of 10 tubes each, the tubes being 4⅝ in. in external diameter, by 12 ft. long.

The capacity of each economizer is 19,840 lb. of water, and each has a heating surface of 4080 sq. ft.

From the economizers the feed water passes to feed-water headers over the tops of the boilers, and the feed to each boiler is taken care of automatically by a feed-water regulator.

Boilers

The "New House" consists of ten 600-hp. vertical header boilers. Each boiler is equipped with an oil burning furnace, consisting of a checker brick floor with ashpits divided into three equal aisles, one aisle under each of the three burners.

Each boiler consists of three 42-in. drums, 20 ft. 5⅛ in. long, and 21 sections of tubes, 14 tubes high, each tube being 4-in. diameter by 18 ft. long. The stop valves are 8-in. automatic type, and all joints in risers and pipe lines are of the loose flange ground joint type. On each boiler is a complete installation of soot blowers, and a differential draft gage. In the main riser from each boiler are ½-in. taps and valves for the purpose of making moisture determinations with the calorimeter.

On one boiler, there has been installed a steam flow-meter, recording draft gage, and recording flue gas thermometer. In addition to the foregoing, there are five CO_2 machines each fitted with recorders and indicators, which takes care of two boilers each.

Automatic Regulator

This is the apparatus that controls the fuel oil pressure, the steam to burner pressure and the damper opening, varying each one in accordance with the load demand.

This regulating system consists of an oil to burner pressure regulator, a steam to burner pressure regulator, a damper regulator, water pump and necessary water motors, hydraulic cylinder, tank, and piping drains, etc.

The principle upon which this regulating system works is the varying of the oil pressure inversely with the steam pressure on the main header, and in turn the varying of the reduced steam pressure to burners and damper opening directly with the oil pressure.

Operation

In hand-operated plants, it is generally the custom to maintain a constant oil pressure at the fuel oil pump and to regulate the generation of steam in individual boilers by throttling the burner valve of each boiler, thus increasing or decreasing the size of the fires under each boiler in accordance with the judgment of the operator. When the fact is taken into consideration that almost always the amount of atomizing steam, which is generally at full boiler pressure, is left unchanged, and remains a maximum for all loads and also that as a rule the dampers are left wide open, it can be readily appreciated that an efficient, uniform rate of firing by hand methods is wellnigh unattainable if not impossible.

The automatic regulating system in this plant controls the supply of oil to all burners and the supply of atomizing steam for 10 boilers and one damper regulator controls the damper opening on six and another on the remaining four boilers, all from a single central point. All burners are operated with burner valves wide open, the size of fire being automatically regulated by the regulation of oil pressure. This applies also to the atomizing steam valves. All of the dampers of the six boilers which are controlled by one of the damper regulators are connected to a common rocker shaft and move simultaneously. Similarly, those of the other four boilers function in the same way and are controlled by the other damper regulator.

CROCKETT, CALIFORNIA

BOILER ROOM PERFORMANCE FOR 24 HOURS ENDING 8am 7-21 1920

A	Oil used	Pounds per hour	17720	
B	Water to boilers	" " "	274700	
C	Water blown off	" " "	2500	
D	Water evaporated	" " "	267200	D = B−C
E	Temperature of feed water entering boilers	Deg. Fahr.	226	
F	Total heat per pound of steam at.... pounds Gage Press.	B. t. u.	1193	
G	Total heat per pound of feed water entering boilers	"	194.1	
H	Net heat added per pound of steam	"	1000.9	H = F−G
J	Total heat per pound of water blown off	"	338.2	
K	Net heat added per pound of water blown off	"	144.1	K = J−G
L	Total equivalent evaporation from and at 212 °F.	Lbs.	297000	$L=\frac{D\times H+C\times K}{970.4}$
M	Equivalent evaporation from and at 212 °F. per pound of fuel oil		16.6	$M=\frac{L}{A}$
N	B. t. u. per pound of fuel oil		18761	
P	Steam consumed by burners	Lbs. per hour	3600	
Q	Gross efficiency (boilers only)		80.8	$Q=\frac{D\times H+C\times K}{A\times N}\times 100$
R	Factor of evaporation		1.024	R = H÷970.4
S	Net efficiency (boilers only, deducting steam to burners)		79.7	$S=\frac{D\times H+C\times K-P\times K}{A\times N}\times 100$
T	% steam used by burners		1.34	$T=\frac{P\times K}{D\times H+C\times K}\times 100$
U	Total B. H. P. developed		8030	$U=\frac{L}{34.5}$
V	Number of boilers in service		9.	
W	% rating of boilers		149	$W=\frac{U}{600\times V}\times 100$
X	Temperature of feed water leaving economizers	Deg. Fahr.	226	
Y	Temperature of feed water entering economizers	"	182	
Z_1	Rise in temperature of feed water in economizers	"	44	
Z_2	Temperature of flue gases leaving boilers	"	563	
Z_3	Temperature of flue gases leaving economizers	"	375	
Z_4	Drop in temperature of flue gases through economizers	"	188	$Z_4=X-Y$
Z_5	CO_2 (Averaged from recording charts)	%	13.0	$Z_5=Z_1-Z_2$

NOTES—In order to be able to compare the performance of the boilers from day to day, five barrels of oil should be deducted from the total amount of oil used during a day when a cold boiler has been fired up and put on the line. No deduction should be made when starting up a cold economizer
All values given above are the average for the 24-hour period.
For purposes of this log, assume dry steam leaving boilers.

Total amount of water fed to boilers per week

Amount of purified water fed to boilers per week

% purified water to total water fed to boilers per week

Claude Brown
Power Engineer

FIG. 2. DAILY LOG SHEET OF AUTOMATICALLY CONTROLLED OIL-BURNING PLANT

Any variation in steam pressure of the main header due to a variation in the load demand is the primary means of control of a steam governor which varies the oil pressure in the oil headers. When the main steam pressure drops, due to increased demand for steam, the regulator increases the oil pressure in the oil headers, which in turn increases the size of the fires and consequently the rate of evaporation. An increase in steam pressure in the main header works the other way and tends to reduce the oil pressure. In this way, a state of equilibrium is reached for any given steam demand rate.

In the steam to burner regulator, the actuating elements are opposing steam and oil diaphragms with areas and leverages conforming to a ratio of approximately 4 to 1 between atomizing steam and oil pressure. The movement of the diaphragm actuates a balanced valve which admits water pressure to one side of a piston which is directly connected to valve in the steam line. Any increase in oil pressure causes an increase in the

pressure of atomizing steam in accordance with the above ratio. This is accomplished by means of the action of a butterfly valve in the steam to burner main. Thus the steam to burner pressure is regulated by the oil pressure.

In the damper regulator the oil pressure is again the controlling factor. A diaphragm is actuated by the pressure of the oil in the fuel oil header, its movement is opposed by a lever connected to a coil spring, which is adjustable along the lever for the purpose of obtaining the required range of motion of the dampers for a given range of oil pressure. A double-ported valve connected to the controller, admits water from the pressure supply system, either to the top or bottom of a hydraulic cylinder which actuates the aforementioned rocker shaft to which the dampers of all the six boilers in one case and the four in the other, are connected.

The action of these regulators is entirely automatic. To cut out any of them it is necessary only to close the valve between the oil header and the oil to burner regulator, bypass the steam to burner regulator or cut off the pressure supply water to the damper controller hydraulic cylinder, opening both drain valves, which will allow the dampers to be thrown wide open by their counter weights and regulated by hand.

When the automatic control has once been set, little trouble is experienced with it. The accompanying log sheet for May 12, 1920, will show the results obtained with the automatic control system.

After all boilers have been put on and the fires started, it is the practice at this plant to equalize all the fires and make refined settings of both steam to burner and damper controller. When the respective dampers are set the fires are equalized by slightly opening or closing all of the burner valves, setting them so that they pass just enough oil for complete combustion, which is indicated by a slight smoky haze as seen through the side peep holes of the boiler. Similarly the steam to burner supply is adjusted by slightly opening or closing all of the supply valves on the burners.

While this system results in a large degree of saving in manual labor, it does not dispense with any large number of firemen. We have at this plant a total of 32 boilers. The boiler-room crew consists of one fireman and two water-tenders per shift and a repair and cleaner gang of nine men, all under the supervision of a boiler-room foreman.

The saving as obtained with the various above-mentioned devices comes in the increased economy as obtained with automatic regulation over hand regulation. With the automatic regulation, the personal element is eliminated and as long as the apparatus is kept in good order more dependable, economical and efficient operation is sure to result.

The load on the boilers in this particular plant is extremely variable, due to the fact that the vacuum pans, which are the greatest users of steam in the refinery, are started and stopped at intervals of 2 hr. each, inasmuch as the time necessary to boil a pan consisting of approximately 80 tons of sugar is almost 2 hr. The steam demand for each pan often reaches a maximum of 50,000 lb. per hr. and there are 12 such pans in the house. There is, however, some division of the individual demands, due to the number of units.

The boilers in the plant are thoroughly overhauled and cleaned every 70 days, and, due to the fact that about 50 per cent of the water evaporated is return condensate and the other 50 per cent is thoroughly treated with lime and soda, little scale is found on the tubes.

In this connection, it might be interesting to note that not a single tube was lost between February, 1920, and November, 1920, although the boilers were operated at approximately 150 per cent of rating continuously. The reason for this was probably that sample cocks were installed in boiler caps under the center of each drum on the rear header and samples of boiler water taken therefrom at regular intervals. In no case was the salinity, or NaCl content in the water, allowed to exceed 300 parts per 100,000. If any drum showed a larger content of NaCl than 300 parts per 100,000, that drum was blown down longer than the others until a test of the water it contained showed decreased salinity. From the foregoing, it will be seen that this boiler house is as nearly automatic as it is possible to make it and the accompanying log sheet shows the results obtained on any average operating day.

A New Form of Belt

By J. H. Blakey

AT A meeting of the Societe d'Encouragement pour l'Industrie Nationale held in Paris on Dec. 18, Mons. Guillon gave an account of a new form of belt which he has been using, and which he calls the "octopus belt." The two desirable qualities of a belt are resistance to traction and a high coefficient of friction. Oak tanned leather, which offers the greatest resistance to traction, has a low coefficient of friction (0.15 to 0.35) because it is lacking in suppleness and elasticity. The same is true, though in lesser degree, of other materials used for belting, such as cotton, camel's hair, etc.

Chrome leather impregnated with tallow has a high coefficient of friction, but small resistance to traction. Consequently, Mons. Guillon has tried a combination in the following manner. A belt of material of high tensile strength, such as oak tanned leather, balata or cotton, is punched for rivets along its whole length. Strips of chrome leather impregnated with tallow are riveted on the inside of this belt in the direction of its length, hollow rivets being used. The purpose of this is to allow the free escape of any air which may be drawn in when running at high speed. With such a belt, coefficients of friction as high as 1.50 and even 1.78 have been reached.

In one case an old belt having 17 cu. cents. of section was replaced by an "octopus" having half this section. The smaller belt was found to transmit the 50 hp. which was required, and the pressure on the bearings was reduced from 3.16 to 1.09. A comparison of two belts of the same transverse section showed that the "octopus" was able to transmit 80 per cent more power than the belt previously used. With the "octopus" it is possible to connect a pulley 3 ft. in diameter with one 5 in. in diameter, the distance from center to center of shaft being 5 ft. With this arrangement, 9 hp. was transmitted with the belt running at 6½ ft. per sec.

"Surpassing, not equaling previous records leads to advancement."

Boiler Plants

Arrangement and Operating Methods to Secure Maximum of Safety*

OF COURSE all local laws and ordinances, requirements of insurance companies and the Boiler Code of the A. S. M. E. should be complied with, as these are fundamentals for safety. But there are additional precautions that may well be taken to insure freedom from accidents and long life to the plant.

In carelessly kept boiler rooms, the stumbling hazard is present in an aggravated form, loose coal being a prolific cause of accidents. If firing tools are carelessly placed, one is almost certain to find in the same room, steam hose carelessly thrown down, wheelbarrows left projecting from dark corners, skids or planks behind the doors, and scores of other accident hazards.

Space from the furnace door to the wall of room, other boiler setting, coal pile, or other obstruction, should be sufficient to permit withdrawal of the longest tool without inconvenience. If there is sufficient space beside the boiler, racks for tools should be provided on the boiler setting. Other suitable places may be the front of the setting, the wall of the room in front of the

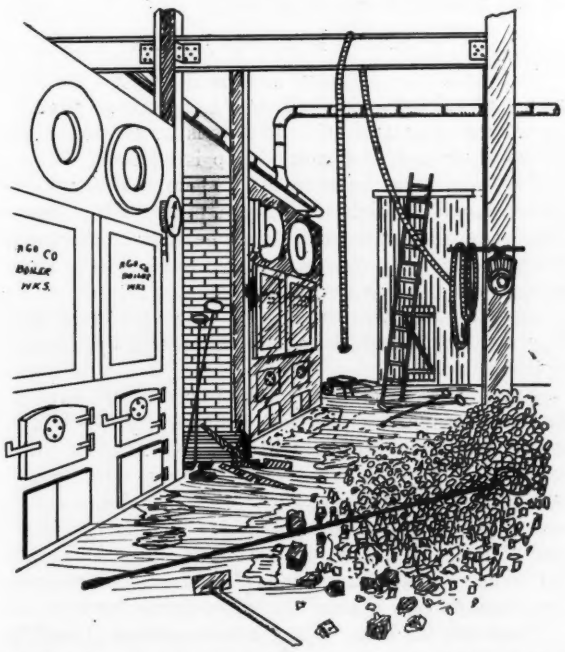


FIG. 1. NOT UNUSUAL CONDITIONS IN A BOILER ROOM WHERE ACCIDENT HAZARDS ARE GIVEN NO ATTENTION

boiler, or the back of the boiler setting. Tool racks must be substantially built, must prevent falling of tools and must not form obstructions. Racks recessed in walls are usually satisfactory.

The practice of allowing tools to lie on the floor is inexcusable.

Two or more ways of exit should be provided from boiler rooms, should be plainly marked and illuminated and the exit doors should swing out from the room.

Boiler-rooms are often slighted as regards both lighting and ventilating. Coal seems to suggest dirt, darkness, and disorder to the unthinking, but the visitor to this department is often struck by the painstaking efforts of the firemen in their attempts to secure order and safety.

Runways and Floors

Elevated runways should be strongly constructed and adequately railed and protected. Entrance should be by metal or concrete stairways, with the flooring of

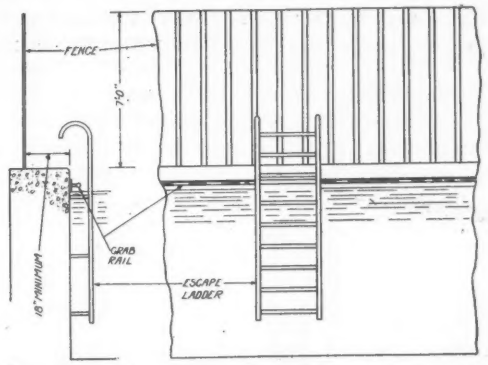


FIG. 2. SAFETY PRECAUTIONS FOR FEED WATER RESERVIOR

grating type rather than of solid construction—the likelihood of accumulating coal dust on closed construction influencing the choice. Several levels of runways may be found in the properly equipped and up-to-date boiler-room, whereas in the older construction ladders were depended upon to reach the several points necessary in the course of the day's work. In addition to stairs and runways, chain or indirect control of several of the vital valves and safety appliances will be found most advisable.

Brick flooring is sometimes recommended in handbooks on this subject. While it is a nonconductor of heat it lacks smoothness, consequently does not lend itself to efficient operation. Types of floors may be different around boiler settings and under coal piles. Floors immediately around boilers should be of metal plate with abrasive surface or of concrete. Under the coal pile, concrete will afford suitable footing and will not interfere with use of the shovel. Metal plate or grating with nonslip surface should be used where an ash conveyor is let into the floor.

If inclines are used the grade should be 20 deg. or less from the horizontal. The structure should be rigid with unobstructed passageway and footing made secure by cleats, if the incline is of plank, spaced 14 in. apart and running from guard rail to guard rail at right angles to the line of travel, except where center or side runways are necessary for wheelbarrows or trucks. No splinters, cracks or irregularities should be tolerated. For cement or similar floors an anti-slip surface should be obtained by rough floating or by mixing 1½ lb. per sq. ft. of surface of grit such as alundum into the finish coat, then sprinkling a like amount of grit over the surface before rough floating. Preferably passage should be permitted in only one direction at a time in order to avoid collisions.

* Prepared by the Engineering Department of the National Safety Council.

Storage of Fuel

If coal is dumped from railroad cars into a hopper a metal grating should be used near the top of the hopper to prevent workmen falling into it. The grating should be of such character as to permit efficient handling of coal and at the same time to afford maximum protection for workers.

When entering a bin a workman should wear a safety belt and life line, the upper end of the line being securely attached to some stationary object, and a companion workman keeping the line adjusted short enough to prevent the man in the bin from being drawn under the coal.

Water Supply

When a reservoir is used as a water supply, it should be fenced to a height of at least 7 ft., with 18 in. or more

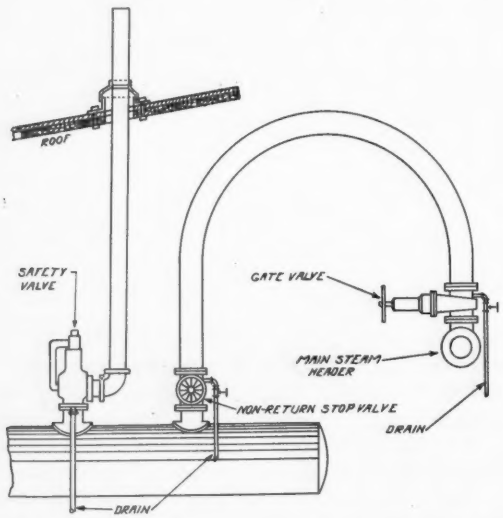


FIG. 3. CONNECTIONS OF SAFETY VALVE AND MAIN STEAM OUTLET TO INSURE SAFE OPERATION

allowed between fence and curbing for use in cleaning or emergency work. Gates should be securely locked and admittance refused to any except specified workmen. The usual rail guards are not sufficient protection for reservoirs. If side walls of the reservoir are perpendicular or slope in at a sharp angle, a safety grab rail at about water level will, at times, prove valuable in preventing accidents; also a fixed ladder or stairway should be installed to reach low-water mark, as a means of escape in case of accident.

In the economizer, the temperature of the water is frequently raised nearly to that in the boiler. As the economizer is under the same pressure as the boiler, precautions should be taken to maintain and operate the economizer with the greatest care. The water should enter the boiler after passing through a check valve, and a safety valve should be provided for each economizer.

Settings and Connections

Many engineers recommend that the tops of boiler settings be made flat so that the repairmen are provided with a rapid means of escape from tops of the boilers in an emergency, and with a safe route to travel in their work. This is done by filling around the drums or shells with an insulating compound, with 4 or 5 in. of concrete on top. If flat top settings are impracticable, a continuous walkway (with standard railings and toeboards) should be provided over each bank of boilers, arranged so that steam valves and safety valves are accessible from it.

Safety valves should not discharge across the tops of boilers. Direct the discharges upward and have them above the heads of men who might be working around them, or better have them carried through the roof. The outlets should be at least 7 ft. above the roof level. Where discharges are not self-draining, open drains of non-corrodible material should be placed at the lowest possible points to insure against collection of water, and discharge of much hot water when the valves open. Drains should be piped away from the tops of boilers.

Leaving the boiler and superheater the steam should pass through a triple-acting valve and an ordinary stop valve into the steam main on its way to the prime mover. Safe and convenient access to each valve should be provided (preferably two) by means of stairs or walkways equipped with railings, with sufficient headroom (at least 6 ft.) and adequate illumination should be provided. Steam connections, valves, and main are all specifically set forth in handbooks on boiler practice and the best practice should be followed.

Operating Rules for Boilers

If a boiler in a battery that is in service has been cut out of use for a time sufficient to permit all parts of the setting to become cold, or if it is a new boiler, the following method of starting it up is advised:

The stop valve between the "goose neck" and the header should be tight; the drain pipes in the "goose neck" and the drain valve underneath the non-return valve should be open; and the connection to the steam gage should be open and in good condition.

Open the feed valve and fill the boiler gradually until the water level stands, between the first and second cocks of the boiler.

Start a light wood fire in the furnace, and have the damper in the stack practically closed. The escape of smoke from the setting will indicate any air leaks, unclosed doors or other defects which are undesirable when a boiler is in service. If any such leaks are observed, they should be corrected before going further; in case of a new boiler, or a boiler with new brickwork in the furnace, this preliminary heating should be continued for a day or two, if possible, before going further.

Continue the firing with gradual addition of coal, the damper being adjusted to the requirements, until all the air is driven from the boiler and steam is escaping from the proper channel. A period of at least 2 hr. should be occupied in bringing the steam pressure in the boiler up to the pressure in header; as stated above, if the boilers are new a much longer time should be taken.

While steam pressure is rising in the boiler, the gate valves between the boiler and the steam main should be slowly opened. This leaves the boiler still shut off from the main by the non-return valves. When the pressure on the boiler has reached the required pressure, the non-return valve will open automatically, placing the boiler in connection with the main steam system.

Before commencing heavy firing, corresponding to the service in the remainder of the battery, lift the lever

on the safety valve to see that it is free to act, and observe at the earliest opportunity whether this valve lifts at the allowed pressure of the boiler or below that pressure.

At this time the stop valve in the boiler feed pipe near the feed main of the boiler house should be wide open, also the stop valve between the check valve and the boiler; the feed controlling valves should be adjusted by the water tender to an opening such as will provide the required water delivery.

Checking Fires, Blowing Down

Checking fires by opening fire doors so as to permit an inrush of great quantities of cold air into the boiler setting end to the stock is bad from an economic standpoint, and subjects the boiler and setting to undesirably rapid changes of temperature. Instead of this it is suggested that ash doors, or other draft supply, be closed, and that, if further checking is necessary, dampers be closed. Finally, if necessary, open fire doors gradually.

The bottom blowoff should be used at least once every 12 hr., the valves in the blowoff connections being left open for a period of ½ min. or longer, depending upon the character of the feed water supply. A boiler should not be emptied before the setting has cooled.

Laying Up Boilers

If for any reason a boiler is to be taken out of service, the following procedure should be observed.

Check the dampers and allow the fires to burn out, at which time the non-return valve will be seated; then close the gate valve in the branch next to the header, open the drains in the "goose neck," and shut off the stop valves in the feed pipe.

Rapid cooling sets up undesirable strains in the equipment. Cool as slowly as time will permit. A small amount of air may be passed through the furnace to assist in the cooling, by opening doors and dampers slightly. After the boiler is cool the blowoff valves may be opened and the boiler drained.

If for any reason the boilers are to be laid up indefinitely the following precautions should be taken to provide for safe conditions when boilers are again put into service.

Thoroughly drain the drums and tubes and clean them inside and outside. Then completely fill the boiler and replace covers which have been removed. This method is not practicable when boilers can freeze. In such cases, after cleaning the boilers, dry them thoroughly and place a pan of lime in each drum to absorb moisture, but do not replace manhole covers. Some companies prefer to clean and dry a boiler and then smear the inside of the drum and tubes with a heavy crude oil or fuel oil. This should be put on with a swab, and when putting this on in a drum an electric lamp should be used, and not an open torch. Drums and tubes should be left open. Mud drums, headers, and tube caps should all be cleaned and similarly coated.

In all places where freezing may occur, care should be taken to drain water from all parts or fittings, or, where these cannot be drained (as in the case of steam gages) they should be removed and stored in warm places.

The above assumes that the boiler is separated from the main header by two valves, a gate and a non-return. In case this condition does not exist, or if the valves leak, a blind flange should be inserted between the boiler and header.

Cleaning Boilers

Blowoff valves, stop valves in the "goose neck" next to the steam header, and the stop valve in the feed pipe next to the feed header, should all be locked shut and the keys retained in the possession of the man in charge of the subsequent cleaning operations. Place on the handle of all of the above valves a suitable sign as follows: "Man Inside Boiler: Do Not Touch."

Manhole covers may then be removed and the boiler opened up for cleaning.

Previous to entering the boiler it is advisable to determine whether there is any gas or bad air present, by passing a torch or candle inside.

It should be an invariable rule that the man who enters the boiler for the purpose of inspection, and who is in possession of the keys locking the above-mentioned valves, must give the final assent for the return of the manhole covers to their places.

FIG. 4. CASING FOR LOCKING UP VALVES TO BOILERS WHILE WORKING INSIDE

For locking the valves as advised above the following method is suggested: Make a loose cover for the hand wheel of the valve out of sheet steel. This cover is simply a circular box made in halves and hinged at one side, with a hole in the bottom for the valve stem. On the side opposite the hinge provide a staple and hasp so that the box can be locked shut. This box can be painted bright red, with the word "Danger" in another color. For large steam valves, this box may also have a sleeve extension to cover the valve stem, thus preventing the use of a wrench on the stem of the valve.

Cleaning of the setting of coal fired boilers should not be commenced until all the flue dust and other material, also the walls of the settings, have been cooled to a temperature where there is no possibility of a man being burned by touching them. The cleaning of gas fired boilers will necessitate an additional precaution in the way of testing the chambers by means of lighted candle or torch to detect the presence of gas or bad air before a man undertakes to operate therein, and, furthermore, the gas valve leading to such a boiler should be locked shut and the key retained in the possession of the man in charge of the subsequent cleaning operations. A sign: "Man Inside Boiler: Do Not Touch," similar to that to be placed on the steam feed and blowoff valves, is to be placed on this valve also.

Leaks in Steam Systems Under Pressure

If for any reason, such as blowing out of gaskets, vibration, over-straining of pipes or general deterioration, the joints of steam pipes develop objectionable leaks, the application of wrenches to bolts of such joints while under steam pressure should be absolutely prohib-

ited. If such joints are to be repaired it should be done after the pressure has been removed from the particular section where the trouble occurs.

If the tubes of a fire-tube boiler develop leaks at the tube sheet, expanders should not be applied to the ends of the tubes while the boiler is under steam pressure. If a leak develops at any part of the sections of a boiler, whether in the headers to which the tubes are attached or at a riveted joint, the use of a calking tool to stop this leak while the structure is under steam pressure should be prohibited. This applies to rivets as well as plates. All such repairs should be made after the steam pressure has been taken off the boiler.

If a leak develops at the handhole plate, manhole cover or around the tube caps of boilers it should not be stopped by tightening up the bolts while steam pressure is on the boiler.

Operating Steam Valves

Rising stems of valves should not be permitted to become rusty or covered with dirt so that they cannot be moved the full extent of their travel at any time. A periodic inspection, not less than once a month, of all valves, stems, etc., in all the main piping systems about the boiler house is recommended. Too much importance cannot be attached to keeping the valves in such condition that they are always ready for use. Great care should be exercised in using a wrench or bar in opening or closing a valve. The abuse of this means of facilitating the handling of valves may result in damage or accidents to seats, threads and stems. Steam should always be admitted to empty piping very slowly. If any portion of the piping has remained unused for an hour or more it is important that it be completely drained before steam is again turned into it.

Water Columns and Try-Cocks

Water columns should be blown out completely at least twice every turn. If a gage glass is fouled internally, so that the water level is not clear, the glass should be cleaned or replaced as soon as possible. If the fouling of the gage glass occurs frequently, it is due to some characteristic of the water, such as suspended matter, scale solvents or lubricating oil, for which some remedy should be devised. Try-cocks should be used at least twice every turn, which regular use will keep them in good working order.

In General

In every well-ordered department it is the duty of specified workmen to operate certain valves in case of accident. Where there is both direct and indirect control of important valves, team plays should be devised to reach both controls at the earliest moment. Gates and valves are occasionally found depending entirely upon indirect control. Direct control should also be provided.

No one should be allowed to remain unnecessarily in a boiler-room. Visitors are not only in danger if an accident occurs, but are likely to distract the attention of the boiler-room employes and cause them to neglect their important duties.

Provide adequate illumination in the boiler room; if not natural, install an efficient system of incandescent lamps. Because boiler rooms naturally possess a minimum amount of reflecting surfaces, lighting facilities should be increased rather than reduced, as is the common tendency. Provide natural illumination wherever possible.

Good ventilation should be provided for basements and subways to boiler rooms, where there is grave danger of the accumulation of noxious gases.

Remove or minimize every stumbling hazard in the boiler-room. Tools in racks, steam hose in its place, proper drainage of wet places, and safe disposal of fuel, all will prevent accidents.

Scale in boilers causes bulges, and ruptures of boiler shell—usually leading to explosions. Remove the scale frequently.

Never exceed the safe working pressure allowed for each boiler as given on the inspection certificate.

Do not allow spare parts and material to accumulate in out-of-the-way places about the room; return them to the storekeeper. They may cause a slip or a trip or may fall and injure someone.

Avoidable Waste

By J. B. Dillon

MANY have heard the story of the man who wanted a window pane of certain dimensions and for his measurement, he spread out his arms so that the palms of the hands were separated the proper length. He started down the street to the glazier holding his arms outstretched, but, just as he entered the glazier's shop, he stumbled, his arms flew upward and you can guess the rest.

Now, if you will watch the manner in which some installers work, you will get an idea of something worse than the method of measurement mentioned. Where one foot of wire will easily fit, they pull in two, cut it off and drop the excess as scrap. After this has been going on for an hour or more, enough wire has been wasted to wire a residence.

That is all wrong and even a beginner should know better. Some may contend that there should be no occasion for any scrap. I fear this is stretching our hope too far, for the amount of time required for such exactness as would eliminate all scrap would be far more costly than the allowance of a reasonable amount, yet there are many "jobs" done where there is a tremendous amount of waste, whereas there should be little, or none.

Habits grow. Get the right idea and make it a habit.

Disposing of Fire Killed Timber

It has been the practice to allow fire killed timber to stand in the forests, because it was considered that most of it was useless for commercial purposes. That this was not done in all sections, we are advised by a recent report; or, even to think of such a thing is untenable.

The report states that 11 yr. ago 561 poles belonging to the Rifle, Colorado, Light, Heat & Power Co. were taken from the fire killed timber, treated with creosote and today more than 90 per cent of these poles are still sound. The government is giving to farmers much of this fire-killed timber and they are using it for fence posts and other small structures about the farm.

Some Recent Developments in Large Steam Turbine Practice

ABSTRACT OF PAPER READ BEFORE THE INSTITUTION OF ELECTRICAL ENGINEERS BY K. BAUMANN, AS REPORTED IN ENGINEERING

THE general trend in the development of large steam turbines towards the maximum possible output at the highest possible speed is justified for several reasons, the most important of which relate to reliability, thermal economy and first cost. This development towards large capacities is conditional on a corresponding development of the driven machine with which the turbine is directly connected or, alternatively, of gears used for transmitting the power to the driven machine.

The only machine which comes under the first category is the turbo-alternator. From a purely electrical point of view, the development of the high-speed alternator is not justified. The high-speed alternator is less efficient than the low-speed alternator, and its first cost is practically the same. Nevertheless, the advantages of the high-speed turbine fully justify the special endeavors of the electrical engineers to overcome the obstacles which may be faced in keeping pace with turbine development.

A study of turbo alternators built during the past ten years reveals the fact that the largest alternator, with a speed of 1000 r.p.m., was built by a German manufacturer in 1918. This set has a maximum continuous rating of 50,000 kw., but is very expensive and future progress will be towards increasing the output of 1500 r.p.m. machines rather than developing 1000-r.p.m. sets.

The largest 1500-r.p.m. machine at present in operation has a capacity of 35,000 kv.a. A 35,000-kv.a. alternator has been built for a speed of 1800 r.p.m. and the capacity of this machine is equivalent to 50,800 kv.a. at 1500 r.p.m. on the basis that the maximum possible capacity varies inversely as the square of the speed.

In the field of high-speed turbines (2400 r.p.m. and above) which have been built during the last ten years the capacity has increased in this country (England) from about 3000 kv.a. in 1912 to 17,200 kv.a. maximum continuous rating in 1921.

During the past few years, the direct-current generator driven directly from the turbine has disappeared. Its place has been taken by the moderately low-speed generator driven by mechanical reduction gear up to units of 4000 kw., and for larger units by turbo alternators in conjunction with rotary converters. The mechanical reduction gear has completely revolutionized turbine practice for small outputs and the time is not far distant when even the 1000-kw., 3000-r.p.m. turbo-alternator will be replaced by a turbine running at a high speed and driving the alternator through gears.

As in the case of the alternator, the development of the reduction gears towards a maximum possible output of speed is justified only from the turbine point of view. For a given speed of the low-speed shaft, the cost of the gear increases with increasing pinion speed, but the more expensive gear is fully justified by the higher efficiency of the high-speed turbine and its lower cost. While the gear is lagging behind the turbine in

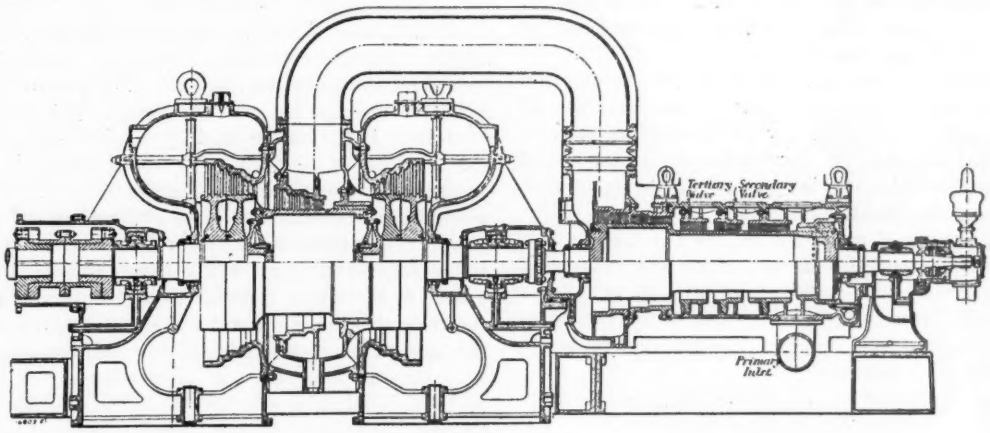


FIG. 1

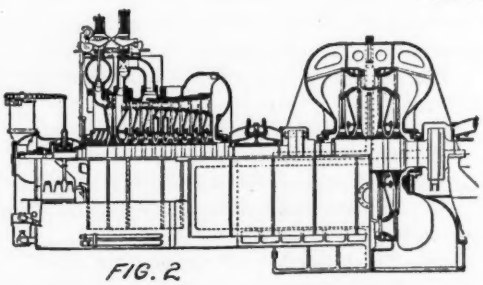


FIG. 2

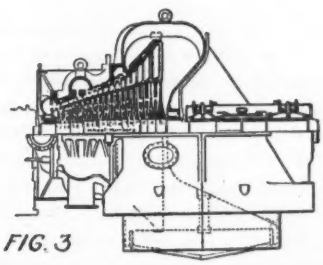


FIG. 3

FIG. 1. TANDEM COMPOUND TURBINE WITH DOUBLE FLOW LOW PRESSURE ELEMENT BUILT IN 1914. FIG. 2. TWO CYLINDER 30,000-KW. IMPULSE TURBINE. FIG. 3. SINGLE CYLINDER 35,000-KW. IMPULSE TURBINE

the race for maximum power, the fact must not be lost sight of that the gear is in the early stage of its development.

In reviewing the general trend of turbine development during the last ten years, reference must be made to the increase in size of units quite apart from the speed of the turbine. In view of the increase in size of power stations, there has been a considerable demand for turbines of large capacities. In this country progress in this direction has been retarded mainly on account of the war, and the development of large units has taken place mainly in the United States.

Development of the Reaction Turbine

In both England and America, the development of the reaction turbine has proceeded on different lines. In England, the two-cylinder design for large machines has become standardized, the high and low-pressure elements being arranged in separate cylinders. The two cylinders are arranged in tandem for driving a single generator. In order to cope with large volumes of exhaust steam, the low-pressure element is generally of the double flow type. Figure 1 shows a representative American machine of this type.

In America, the idea of subdividing the turbine into separate cylinders has been carried even farther. In order to improve the efficiency of the turbine and to deal with the demand for increased capacities, some of the units are built for driving more than one generator, thus evolving the multi-shaft idea.

During the period under review, the Ljungstrom turbine has been put on the market. The first turbine of 1000 kw. capacity was installed in 1912 by the North Metropolitan Power Co., London, and since then considerable progress has been made with regard to increase in capacity per unit.

A Ljungstrom turbine of 30,000 kw. capacity is at present under construction in the United States.

Development of the Impulse Turbine

A conspicuous feature of the development of the impulse turbine is the increase in the output per cylinder. It is interesting to note that the first 30,000-kw. turbine, Fig. 2, which was built in 1914, is of the two-cylinder type, and that very shortly after this machine was built, a 35,000-kw. maximum continuous rated turbine, single cylinder type, was developed by the same company (see Fig. 3). The necessary leaving area in this single cylinder unit has been obtained by increasing the diameters of the last stages and increasing the length of the blades. In comparing the two designs which are shown to the same scale, one is immediately struck with the great difference in overall length, and the additional cost which is involved in the two-cylinder construction. Both factors are no doubt responsible for the early change-over from the two-cylinder to the single-cylinder construction. Experience has shown, however, that this single-cylinder construction possesses serious inherent disadvantages which are due to disc and blade vibrations.

In England, the design of the Rateau turbine has undergone considerable development and the modern machine of this type possesses some novel features. The stream line exhaust was introduced to secure a single flow of steam from the last row of blades to the condenser. This feature reduces to a minimum the pressure drop between the last row of blades and the condenser.

A surface type feed-water heater arranged within the turbine cylinder as an integral part of the turbine avoids the necessity of additional heater casings and pipe connections which would complicate the layout of the plant to a considerable extent.

The pipe type of nozzle-box and steam chest has been evolved and combined with nozzle control, the design being such that the highest steam pressures and temperatures can be used without fear of distortion of the cylinder.

Important Factors Affecting the Development of Large Turbines

The principal factors which influence turbine design are summarized in their order of importance as follows:

(1) Reliability.
(2) Working conditions.
(3) Thermodynamic efficiency.
(4) Overall dimensions, weight and costs.

Reliability

The maximum size of turbine which can be used for a given size of power station depends to a great extent on the reliability of the machine. The greater the reliability of the turbine available, the larger may be the capacity. If the larger capacity can be obtained only at the sacrifice of reliability, it would obviously be bad engineering to utilize such larger size. Even if the reliability of the different sizes available is the same, the power station itself will be less reliable with a small number of large units than with a larger number of smaller units. It is evident, therefore, that in order to maintain the reliability of the power station at a given standard, the larger machines should be more reliable individually than the smaller machines. The adoption or otherwise of large turbines should be settled only by the recognition of this principle. Any so-called progress in turbine capacities should be carefully examined from the point of view of reliability. A step in the wrong direction may cause failure, which is bound to retard further progress.

The reliability of a turbine depends on the following factors:

(a) The stress to which the material is subjected.
(b) The magnitude and type of vibration to which the different part of the machine are subjected.
(c) The stresses due to uneven distribution of temperature.
(d) The reliability of the material itself.
(e) Care during manufacture and erection.

Working Conditions

Of the various methods by means of which the thermal efficiency of a power station can be improved, those with which we are concerned in this paper fall under two main categories:

1. Operating conditions which are under the control of the power-station designer.

2. Conditions which are under the control of the turbine designer.

Improvement of operating conditions comes under the former category, and improved turbine thermodynamic efficiency is under the control of the turbine designer.

Where in 1912, 180 lb. per sq. in., 150 deg. F. super-

heat, and 28-in. vacuum were considered standard conditions, at present, steam pressures as high as 350 lb. per sq. in. (gage) are being adopted for new power stations, and temperature as high as 750 deg. F. The vacuum has been increased from 29 in. to 29.1 in. The heat drop has been increased from 407 to 485 B.t.u. per lb., i. e., by nearly 20 per cent, and the ratio of expansion has increased from 418 to 828, i. e., in the ratio of 1 :2.

Higher steam pressures than 350 lb. per sq. in. are at present not justified except in power stations where economy is of extreme importance, where coal is very expensive and the load factor very high. A steam temperature of 700 deg. F. is the present standard. This means that the turbines must be made suitable for steam temperatures up to 750 deg. F., to allow for variation from the normal temperature.

The improvement which is possible with large steam turbines, of a given stage efficiency working with dry steam (i. e., hydraulic efficiency) cannot be found directly from a comparison of the adiabatic heat drop and the heat content per pound of steam, because the thermodynamic efficiency of the turbine depends to a great extent on the steam conditions, for the following reasons:

(a) The efficiency of a stage decreases with the amount of wetness in the steam.

(b) The reheat factor varies considerably with the pressure, superheat and the vacuum.

(c) With a given turbine the velocity ratio u/c_0 varies with the total heat drop (u being the mean peripheral speed and c_0 the theoretical steam velocity).

(d) Leakage and disc-friction losses increase with higher pressures, and leaving losses increase with lower back pressure.

Improvements Due to Higher Steam Pressures

In 1919, the author gave an approximate rate for the calculation of the improvement in heat consumption possible with higher pressures. This was to the effect that for every 10 per cent increase in pressure the overall economy is improved by one per cent.

The variation in heat consumption with increase of pressure is plotted in Fig. 4. A curve has also been plotted in Fig. 4 to show the variation in the condensing surface required for the same total capacity in kilowatts.

Figure 5 shows the improvement in thermal efficiency for 10 per cent increase in absolute pressures.

Actually with a given turbine, i. e., a given cost, the improvements calculated above will not be fully realized. It is estimated that on account of the lower value of the ratio u/c_0 and the increased leakage and disc friction losses at the higher pressures, the actual improvement will be reduced by about one per cent for an initial increase in pressure of about 100 per cent(i. e., for a pressure ratio of 2), the total temperature remaining the same, or by about 0.14 per cent for an increase in pressure of 10 per cent.

For a constant superheat, this additional correction should be larger, because the decrease in the value of the ratio is greater for the same increase in pressure; and also because the leakage losses are slightly increased as a result of the larger clearances required for the higher temperatures. It is estimated that in this case, the additional allowance would be 1.5 per cent for a pressure ratio of 2.

This allowance added to the combined thermodynamic efficiency correction for wetness and reheat factor, gives for a ratio of initial pressure of 2, a difference in the thermodynamic efficiency varying from 2 per cent at pressures of 200 lb. to 1.5 per cent at very high pressures. For all practical purposes an efficiency correction of 2 per cent for a ratio of initial pressures of 2 is sufficiently accurate as a guide for comparison of turbine efficiencies. With modern methods of feed heating in which steam is taken from a low pressure stage of the main turbine, the improvement possible with higher pressure will be larger than stated above. It is estimated that for pressures of 200 lb. to 250 lb. per sq. in. the

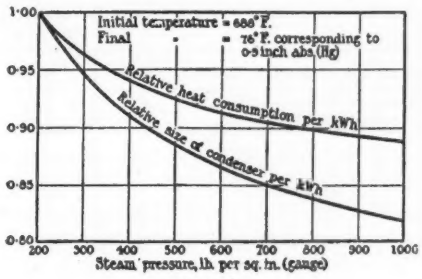

Initial temperature = 688° F.
Final " = 76° F. corresponding to 0·9 inch abs. (Hg)
Relative heat consumption per kWh
Relative size of condenser per kWh
1·00
0·95
0·90
0·85
0·80
200 300 400 500 600 700 800 900 1000
Steam pressure, lb. per sq. in. (gauge)

FIG. 4

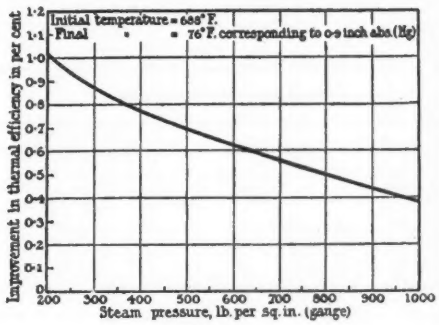


FIG. 5

FIG. 4. RELATIVE HEAT CONSUMPTION AND SIZE OF CONDENSER PER KW.-HR. WITHOUT FEED HEATING, COMPARED WITH 200 LB. PRESSURE, AS A FUNCTION OF THE PRESSURE

FIG. 5. TOTAL IMPROVEMENT IN THERMAL EFFICIENCY FOR 10 PER CENT INCREASE IN ABSOLUTE PRESSURE

improvement for 10 per cent increase in pressure will be approximately 10 per cent larger than stated and for pressures of 800 lb. per sq. in. about 20 per cent larger; the resulting improvement after making this correction and the allowance for increased leakage and disc friction losses is accordingly as given in Table I.

Improvement Due to Higher Total Steam Temperatures

The improvement in heat consumption obtained by raising the total temperature 100 deg. F. is shown in Table II.

Actually, with a given turbine the improvement as calculated will not be fully realized. It is estimated that on account of the lower value of the ratio u/c_0 at the higher temperature, and the slightly increased leakage losses resulting from the larger clearances required with higher temperatures, the improvement will be reduced by about 1.5 per cent for a superheat ratio of 2, for super-

heats from 100 deg. to 400 deg. F. This correction applied to the improvements given above results in the reductions shown in Table III and actual improvements with a given turbine.

Improvement Due to Higher Vacua

The combined correction for wetness and reheat factor for varying back pressures varies from 0.25 to zero per cent for a back pressure ratio of 2. As this correction is small compared with the leaving loss, it follows that the improvement in steam consumption with lower back pressures can be calculated directly from the increase in heat drop with accuracy which is sufficient for all practical purposes. To obtain this improvement it will be necessary, however, to increase the number of stages to deal with the larger heat drop, and to increase the exhaust capacity of the turbine to deal with the larger volume at lower back pressures.

TABLE I. IMPROVEMENT EFFECTED BY INCREASING PRESSURE

For Pressures Between	Approximate Actual Improvement for 10 per Cent. Increase in Pressure.	
	Without Feed Heating.	With Modern Method of Feed Heating.
	per cent.	per cent.
200 lb. and 250 lb. per sq. in. (gauge)	0·85	0·95
400 lb. and 450 lb. per sq. in. (gauge)	0·65	0·75
600 lb. and 650 lb. per sq. in. (gauge)	0·50	0·60
800 lb. and 850 lb. per sq. in. (gauge)	0·40	0·50

TABLE II. CALCULATED IMPROVEMENT DUE TO INCREASING STEAM TEMPERATURE

For Steam Pressures of	Improvement in Heat Consumption for 100 Deg. F.
	per cent.
200 lb. per sq. in. (gauge)	3·47
400 lb. per sq. in. (gauge)	3·66
600 lb. per sq. in. (gauge)	3·88
800 lb. per sq. in. (gauge)	4·02

Improvement Due to Reheating

The heat consumption of a turbine installation can be improved by reheating the steam between stages. Owing to the great additional expenses involved in reheating the steam more than once, and the relatively small additional gain, multiple reheating is not a practical proposition, and the following remarks deal with reheating the steam once only. Figure 6 (curve B) shows the improvement possible with single reheating to the initial temperature at different stages, the initial pressure being 500 lb. per sq. in., the total temperature 670 deg. F. and the back pressure 0.75 in. In calculating the improvement allowances are made for variation of the reheat factor as well as for the improvement of the stage efficiencies resulting from the use of drier steam.

TABLE III. ACTUAL IMPROVEMENTS WITH TURBINE (TABLE II CORRECTED)

For Pressures of	Reduction.	Actual Improvement.
	per cent.	per cent.
200 lb. per sq. in. (gauge)	0·6	2·87
400 lb. per sq. in. (gauge)	0·75	2·91
600 lb. per sq. in. (gauge)	0·89	2·99
800 lb. per sq. in. (gauge)	1·02	3·00

The improvement in heat consumption becomes a maximum when the steam is reheated at about one-third of the adiabatic heat drop, or at one-fifth of the initial pressure, the improvement being 8½ per cent. Actually, it is more economical to reheat at a higher pressure, say one-quarter of the initial pressure, as the cost of steam piping is reduced, owing to the smaller piping required in such a case.

Another advantage obtained from reheating is the decreased liability of blade corrosion of the low-pressure blades.

Improvement Due to Feed-Water Heating

The thermal efficiency of a turbine can be improved considerably by heating the feed water by steam taken from one or more stages of the main turbine.

The Thermodynamic Efficiency

Apart from the steam conditions, the thermodynamic efficiency of a turbine depends on the blading efficiency and the losses outside the blading. The losses which occur in the various types of turbines are so vastly different in character and value, that it is useless to compare the blading efficiencies without, at the same time, comparing the losses incident to the particular types of turbines.

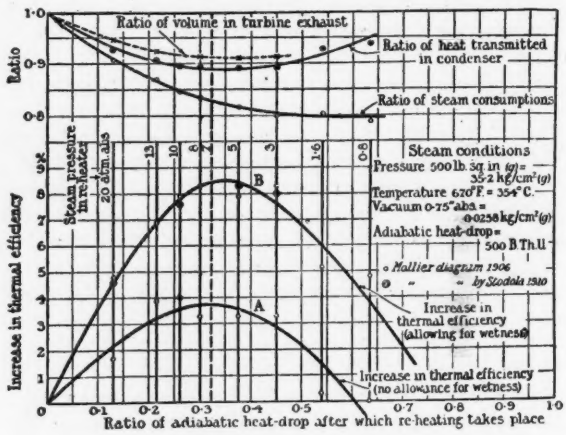

Ratio of volume in turbine exhaust
Ratio of heat transmitted in condenser
Ratio of steam consumptions
Ratio
Steam pressure in reheater
20 atm. abs
Steam conditions
Pressure 500 lb. sq. in. (g) = 35·2 kg/cm²(g)
Temperature 670°F. = 354°C.
Vacuum 0·75" abs. = 0·0258 kg/cm²(g)
Adiabatic heat-drop = 500 B.Th.U.
Mollier diagram 1906
" " by Stodola 1910
B
A
Increase in thermal efficiency (allowing for wetness)
Increase in thermal efficiency (no allowance for wetness)
Increase in thermal efficiency
Ratio of adiabatic heat-drop after which re-heating takes place

FIG. 6. INCREASE IN THERMAL EFFICIENCY OF STEAM TURBINES DUE TO REHEATING

In 1912 there was a considerable tendency towards the adoption of the velocity wheel for the high-pressure end for medium-sized turbines. Owing to the increase in output at a given speed, however, the advantages of the velocity wheel are outweighed by the increased efficiency of single Rateau stages, except in cases where the diameter used for the first stage is relatively small. There is a tendency for the high-pressure end of reaction turbines to be replaced by impulse stages not necessarily of the velocity-wheel type, but also of the ordinary Rateau type.

For the middle portion and the low-pressure end both impulse and reaction blading continue to be used, but, as is evident from the summary of the commercial developments in this country, reaction blading has largely given way to impulse blading.

The merits of one type of blading over the other do not depend so much on the type of blading used as on the detail construction employed in connection with it.

It is obvious that such features as lashing soldered to the blades, commonly used in connection with reaction blades, are less satisfactory from the point of view of steam flow through the blades, and of reliability, than the shrouding riveted to the tips of blades generally used with impulse blading. There is, of course, no reason why this method should not be used with reaction blades, except perhaps the higher costs.

It is necessary that the steam should fill completely the blade passages of the last row of moving blades to insure that the leaving losses are a minimum for a given leaving area. This condition is met by using a small amount of reaction, i. e., the pressure between the last row of guide blades and the last row of moving blades should be slightly higher than the pressure in the exhaust, a condition which automatically obtains when a turbine is designed without reaction in the last stage, but is run at a higher vacuum than that for which it is designed.

The efficiency of a turbine depends, to a great extent, on the average ratio of peripheral speed to the steam speed which would result from the pressure drop over a complete pair of blade rows containing one row of stationary and one row of moving blades.

Hunting Trouble

Experiences Encountered in Unwatering an Old Mine. By John Pierce

SEVERAL YEARS ago, after a severe attack of the "Spanish Flu" and after four weeks of doubt as to whether I would pull through or not, the doctors decided on the latter and informed me that six months was a fair estimate of the time left to me to partake of the joys and sorrows of life. My weight had diminished to 90 lb., whereas before my encounter with the flu I had normally tipped the beam at 180 lb. The old saying, that the good die young, however, held some consolation for me, so to prove that the doctors were all wrong, I decided to go to New Mexico, where I had a few dollars invested in a mining project and which place I considered was a good place to regain my health.

On reaching the property, which was situated hundreds of miles away from civilization, I at first, felt that it would, perhaps, be better to die at once, and not prolong the agony by dying of sheer loneliness in the end. My sympathy for an old Diesel engine which was in even worse shape than I was myself, gave me the necessary courage to hold on—I thought that even if I couldn't cure myself, I might be able to do something for the engine.

That she needed curing was obvious. The mullet-headed manager had, instead of buying a new engine, or at least having this old one inspected by a competent Diesel engine engineer, had looked at the fresh paint on the outside and purchased it, paying just a little more for it than a new one would have cost f.o.b. the factory. In order to justify his action, he contended that he saved the freight rates as this old machine was located very near the point where it was to be used. I found out later that he had received a handsome commission to take it off the owner's hands.

Then to make matters worse, he put her in charge of a Mexican peon who had never, until he saw this one, seen a Diesel engine. The reader can possibly imagine just how long the old machine turned over before it became filled with a desire to lie down and die. The manager becoming thirsty, decided, at this time, to take a course at a St. Louis factory and thoroughly learn Diesel engine operation, though during the three months that he spent there he was generally to be found at the "club" quenching his prodigious thirst. The company, of course, was paying all expenses during this time.

Well, to return to my story, I certainly found trouble—trouble with a big T. I went at it, however, and overhauled the old engine to the best of my ability. I lined it up, set the valves and cams, put in new rings and then advised that the machine be covered with a heavy cloth and kept in good shape for emergency use only. The steam plant was to be operated for general service. This advice was followed, as I pointed out that the Diesel engine was good for probably 1000 hr. more service before being relegated to the scrap heap.

Of course, I was slow doing this work for my strength was a thing of the past and I was running on "low."

During this time, the other men had been preparing to unwater the mine, which was full of water, and so I started the steam plant; that is, I started it after I had made a few changes in the arrangements, for the boiler and furnaces had been arranged by a student of civil engineering and research, who, wishing to demonstrate certain theories regarding combustion, had put one 75-hp. burner under a 250-hp. water-tube boiler, and had built around the burner a tunnel about 12 in. square, extending from the front of the furnace to the mud drum in the rear, airtight from first to last. The grate area he had sealed over completely, allowing no place for the air to enter, claiming that to get perfect combustion there should be a complete vacuum. His arrangement of the furnace was such that the action of the steam and the oil from the burner would produce a vacuum in this tunnel, therefore perfect combustion would result, and at least 50 per cent of fuel would be saved over the other methods of fuel burning.

The designer of this vacuum furnace claimed he had demonstrated this method and had found it successful. I had noticed that there seemed to have been at some previous time an explosion of considerable violence under the boilers, as the walls were all shot out, and several of the castings had been badly broken. Upon inquiring as to how this had happened, he said that he had hardly got his fires going when the explosion occurred and the whole outfit blew up. But this, he stated was because some Mexican with a grievance had fixed up a batch of dynamite under the boiler and naturally when the fires were started the whole thing went, "bang."

Being master mechanic as well as part owner of the works I repaired the furnace to my liking, gave the boiler a thorough examination, placed two 175-hp. burners under her and started her going.

In due time we got the mine unwatered to the point where we decided to start working, although there was still several hundred feet of water below this point.

As we needed only a couple of small motor driven steam pumps to handle and hold the water at this point I decided to run a line down to a station opposite that level and install motors and pumps.

We were generating 250-v. alternating current, and I proceeded to run the lines down one corner of the shaft. All seemed to be fine until I signaled the shaft man to throw in the switch, then things began to happen. I was standing on the wet ground, leaning in a masterful way, against the motor, the motor being insulated from the ground and securely placed upon a nice dry wooden platform, when the switch, as I said, was thrown in, and Holy Mike! what a jolt I got. I promptly got up from where I fell and jumped—jumped right into the shaft, for I thought that the whole world was caving in on me. That cussed research engineer had read some place that all motors and generators should be grounded, and so he had hooked one of the lead wires onto the frame. My body completed the circuit to the ground. I was not a miner in any sense of the word, or I should have jumped somewhere else than in the shaft; but having jumped, I realized my mistake instantly, and fortunately had sense enough to throw my arms around the water column of the air lift, which, of course, went on down into the shaft and the water 40 or 50 ft. below. As this was all slimy, believe me, I had some quick sliding, and when I hit the water, knowing that it was still several hundred feet to the bottom, my prayers, though short, were very fervent, and I suddenly resolved that mining was a bad and dangerous occupation.

Luckily the shaft man had seen something go down the shaft and he rung down the tub (fortunately we were not using cages). I never welcomed anyone in all my life as much as I welcomed that old gray-headed, lousy Mexican. He sure looked to me like an angel in disguise.

I tried to get him to promise to keep it a secret, which he did—for about four minutes, then I had to buy the drinks, which are plentiful down there but costly.

A short time afterwards, finding that we could get no ore in paying quantities on this level, we went on down further and reached the 600 level, where the water was much worse, and very cold, and where I installed a fair-sized Worthington pump, which would just hold the water and no more.

I decided, therefore, to build another foundation and install another pump in order to take care of the water with one while repairing and packing the other, so in the meantime I sent the research engineer to examine and buy the second pump.

In due course he came back, having bought a dandy pump, which proved to be about as fine a pump as one could wish to see, perfect in every detail, but which had been designed and built as a circulating pump for a large surface condenser, and since the purpose for which I wanted it was to throw water to the surface a trifle over 600 ft. from its station, I of course felt bad and the research man felt worse, for we had paid cash for the pump and there was no possibility of our getting our money back.

I then ordered one by wire. It came, and was all ready to be lowered when I discovered that the water was not coming and went down to see what had happened to the other pump, which I found had broken its side rod, or arm, on one side, and therefore had refused to work any longer. The Mexicans, seeing that the pump had stopped and the water was coming up, had climbed to a higher level and were waiting for me to come and "fix it."

The water had reached such a point that, by reaching down I could move the rod by hand, for it had broken off at the spool on the piston rod and had left a long leverage, but I knew that a few moments' delay would bring the water so high that I would be unable to reach it without going under. Then I made my big mistake. I took off all my clothes, hung them above my head, squatted down in the water and began to move that cussed rod by hand, keeping the pump in action in this manner. My mistake was in taking off my clothes, for the steam pipe ran alongside of the pump as well as the exhaust, and every time my body would move a fraction of an inch over, and touch the pipes—wow! How I would swear whenever I produced a blister.

The Mexicans on the 500 level decided to wait until somebody came, as they, like all Mexicans, were enjoying their rest, especially as they had the plausible excuse of not knowing whether it was "fixed" yet; so there I sat, not daring to leave, knowing I was just holding the water. My lamp in the meantime, like all miners' lamps that go out when most needed, having refused to function, left me in the dark.

In the course of about an hour, which seemed to me to have been a century, I heard the tub start up the shaft, and I decided that when the burns on my skin got unbearable, I would go to the surface via the "man way" on the ladders; but shortly after I was pleased to hear an awful cursing coming down the shaft, and I knew that the old mine carpenter was on his way to my rescue.

On his arrival I told him I could keep the pump going awhile longer and instructed him to go back and send the new pump down, and to send the men down the manway, so we could land her in the shaft for the time being and make temporary connections till the other one was in repair again. This he did, but it required that I remain and burn and cuss for another two hours.

Finally, however, it was done and we held the water while the old one was repaired.

Some time later we decided to go still further into the mine, lowered to the 700 level with the airlift, and bought another pump, a fine looker, all blue steel on the outside, and a fine big fellow, which looked so good that I sent it down and put it on the base without a thought but that it was in perfect condition. When I turned on the steam, however, it simply refused to function. I opened it up and eventually had to put jackscrews against the wall and brace it on the other end before I could budge the pistons. When I did finally get her jarred loose she proved to be a wonder, though the blue steel was only a camouflage made by using blue stone on her bright work.

One day I went to town and stayed a few days, resting up. On my return I found that the miners had cut into an underground stream of water, and we were hopelessly drowned out. All this time we had been spending money and earning nothing, so that I now found myself out of money, all my savings having gone into this hole, and out of work, as of course there remained nothing to do but shut her down and give up.

Use and Occupancy

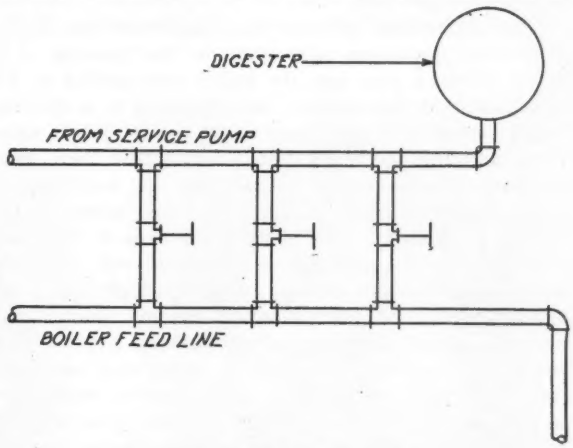
LOSSES DUE TO SHUTDOWNS AND THE RESPONSIBILITIES THEREFOR. BY A. D. PALMER

A LINE of insurance upon which engineers should be well informed and upon which they are not at this time so informed, is that known as use and occupancy. In brief, this line of insurance covers the loss of production in a plant and it is a matter of considerable importance to all concerned. It is a matter worthy of comment, the small number of engineers who can give an inspector any reliable data on the matter of plant production. Most engineers, when the matters of stock on hand, production, contracts, etc., come up, simply refer you to the office, showing that they do not fully understand the job they are assumed to handle. To my mind, this is lack upon the part of the engineer for, if the manufacturer will give all this data to an outside insurance company's inspector, there is no justifiable reason why the engineer can not secure it. If he knows exactly what the plant production is, he will study ways and means whereby he can always keep the production normal at least.

In my engineering experience, I used to figure that a shutdown in the mills was nothing to me; but I look at it differently now, because I see that the beginning of the production is in my hands. The policy I follow now is to study the layout from all viewpoints. If, in going through the mill, I see a condition that is likely to put a department out of service, I find out whose particular job this is, and get in touch with that man and show him the existing defect.

To illustrate how this works out, in passing through a big mill I noted a main driving belt in very bad condition, took the matter up and found that we could not get a belt for this drive under two weeks if this one failed. The engineer insisted that belt supervision was up to the belt man and the belt man took the stand that main belts were up to engineering department. If this particular belt had failed, it would have meant 400 men out of work, with a big loss to the company carrying the insurance, yet I could find nobody who was losing any sleep about the proposition. Personally, in this particular case, I attached the blame to the chief engineer, because if this man had been thoroughly alive to his job, he would have kept his eye on those items that would affect the output from his department. Simply because work is assigned to Bill is no reason for not watching Bill. It is because of this seeming lack of interest upon the part of engineers that insurance companies are forced to send men out to look the proposition over before they can issue a policy on the risk. I have heard an engineer make the statement that it would be absolutely impossible to shut him down flat and have seen an inspector find 10 possible and likely modes of failure in that plant.

In making an inspection, the inspector should first secure such data as he can get from some person in authority in the company's general offices. Here he should endeavor to get in touch with the exact work the assured is doing; he must find out all details of the production, just what the production is per day, and get the details of the process of manufacturing. It is generally well at this time to take up with the assured the matter of improvements, as quite often changes are contemplated which only the heads of the company know anything about, and there is, of course, the possibility that these changes might affect the present operating conditions in every way. As a general thing, a diagram showing the floor plan of the whole plant, with the location of the important details, as boiler, engines, water wheels, elevators, etc., is desired. and the office is generally the proper place to secure this map. Bear in mind that if there is some detail that will affect the production, the exact location of that detail should be shown in the map and the whole story should be told. A good inspector who is thoroughly interested in his work will try to clear up his



PIPING THAT GAVE TROUBLE

office data at the start, thereby not antagonizing the assured by a lot of running to the office.

His next business will be with the officer in charge of the mechanical equipment. This may be a master mechanic and it may be a chief engineer. Here he will ascertain what proportion of the plant provides power for the production.

To illustrate just what information is needed in a case of this kind, let us assume the following: The plant under discussion has two 500-hp. steam engines, one 750-kw. turbine and two water wheels 300-hp. each. Each engine drives a shaft in No. 1 mill. Turbine drives a generator furnishing current to No. 3 mill, all motor drive. Two water wheels furnish power to No. 2 mill. Each mill has a supply of power, but the question is, can we use power from one mill if another breaks down? This calls for careful study. Again, what are the facilities for securing outside power? Is it on the premises? Could arrangements be made whereby power could be secured even temporarily? In the risk described above we find that the engine driven mill has no motors, therefore if we lose an engine, even with a turbine running light loaded, we can look for no help from this quarter. Engines are old and not in good shape, and this would practically condemn the risk as far as the production in No. 1 mill is concerned, based on no stand-by service.

In Mill 2, we find that one water wheel will under normal conditions carry the full load, and this leaves a machine always ready for service. This is a good risk.

In Mill 3, there is a turbine driving a generator. This machine carries about 35 per cent load at its peak. Aside from the uneconomical operation of the turbine under these conditions, how much better it would have been if the assured had installed two 300-kw. machines instead of the one 750-kw. We find that outside power passes the plant but it is of a different voltage and frequency, and here the cost of rigging up even a temporary hitch is prohibitive. In the foregoing, the only real good insurance risk is the Mill 2 with the water wheels.

In steam driven plants, the boiler question is of vital importance. Are there any extra boilers? No. Load is enough for the whole battery, and the loss of one boiler means a reduction in the production. This is a prohibitive risk.

An illustration of just how important the boiler end of the inspection is, is given in the following incident. About a year ago, the writer was notified by his employer that an accident had occurred to a Stirling boiler located in Maine, and to get on the job at once. Upon arriving at the location I found that there were no reserve boilers and that already we were paying heavy damages for the cut in production caused by the loss in production. The cause of the loss of this particular boiler is somewhat unusual, and will no doubt interest engineers in general. Due to a high feed-water temperature, feed pumps would become steambound, and to eliminate this the engineer cut into a service line piped to digesters, from service pump and connected into feed line. (See sketch.) There was no check valve in service line, therefore service pipe was generally full of pulp. In fact, if the valve between service line and feed line was left open, pulp would flow right back into boilers from digesters. This is exactly what happened in the case I am reporting. The boiler filled with pulp. I took seven barrels out of the boiler, glass plugged, and the firemen were running an empty boiler before they knew it.

My company carried both direct damage and use and occupancy on the boilers and my instructions were to stay on the job until the boiler was again in service. In making the inspection after the boiler was cleaned, we found that the tubes had got red hot and had sagged down until they were holding to sheet by about 1/16 in. Our first attempt was to try to force these tubes back into the shell, but after five days' hard work we gave that up, as we found that the tube ends were past rolling. Due to the assured being informed that we could make this boiler tight, nothing was done about getting new tubes, with the result that when the boiler makers gave up the job, we had to locate tubes and get them to the plant. We did secure tubes in Ohio, some distance from Maine, and after about five weeks we managed to get the boiler back on the line. This little affair cost my company a pretty penny and the whole cause could be tracked back to an inspector not reporting lack of tubes, and operating conditions of boilers.

In isolated plants where transportation is bad, an extra set of tubes is of vital importance. In fact, one of the vital considerations in use and occupancy inspections is the matter of spare parts. Study out this matter in this way, if there is some part of a much used unit that is vital to the machine, and that cannot be purchased nor made locally, then insist that that part be kept in stock. While with the master mechanic, go over any contemplated changes and get his viewpoint, and of course keep in mind that your interest in his problem is in the matter of production.

Assuming that there is a master mechanic, don't overlook the engineer, because there is much real data known only to the engineer. An engineer will tell you all about the last shutdown, how it happened and all the details, and in general a good man can figure out just what will happen next time and give a remedy, thereby making himself solid with the engineer.

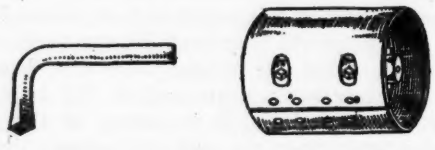
A little detail that I follow up very closely is the matter of getting full data on the units covered by the policy. The companies do not call for this, but often after a use and occupancy inspection has been made, direct damage is desired, with the result that you have all the work to do over again to the annoyance of the assured, the master mechanic, and the engineers, all of which can be eliminated if you take time to get all valuable data on your first inspection.

In doing work of this kind, one wants to take a lot of time and get facts. Too much money is involved to take chances by guessing; see everything for yourself and then you know it's there. Just because the master mechanic tells you that he has 200 tubes in stock is no reason for your believing him. See the tubes and then you know where your company stands.

Socket Wrench Made of Piping

By G. H. Janes, 3rd

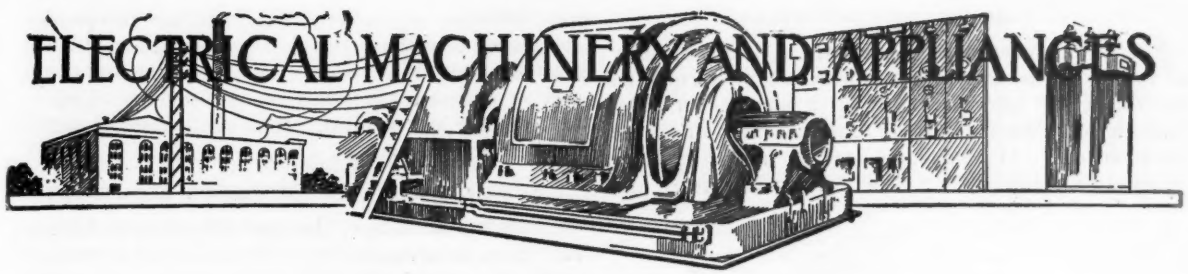
When an electrician is out on motor repair work, he may have to take off a metal pulley; if he carries no socket wrench in his tool kit, considerable difficulty will be experienced in removing the bolts. To meet this situation, the socket wrench shown in the accompanying sketch can be made readily from a short section of metal tubing. The inside diameter should be slightly larger than the bolts to be removed, and the



SOCKET WRENCH MADE FROM TUBING AND METAL PULLEY ON WHICH IT IS USED

outside diameter must be small enough to fit the holes into which the bolt heads are countersunk. The end of the tubing is then squared by striking it with a hammer until it will fit snugly over the bolt head. The right-angle bend is then made to provide suitable leverage.—Electrical Record.

A good workman does not complain about his tools, because he uses good ones, and when they seem dull he sharpens them; likewise his wits.



Maximum Demand Meters

DISCUSSION OF THEIR FUNCTIONS AND A RESUME OF THE VARIOUS TYPES EMPLOYED. BY VICTOR H. TODD

THE NECESSITY for a maximum demand meter and a rate based upon the maximum demand of an installation can best be illustrated by considering two industrial plants consuming the same total energy in kilowatt-hours per day. The first plant, for example, consumes 100 kw. for 24 hr. per day, making a total load of 2400 kw.-hr. per day. But the second firm insists on taking 300 kw. for only 8 hr. per day and remaining idle for the remaining 16 hr. The total kw.-hr. consumption is the same in both cases, but while the supplier of the energy in the first case need only have equipment to supply 100 kw., in the second case the supplier not only must have equipment for supplying 300 kw. but provision must usually be made to supply it at a minute's notice, thus resulting in a higher first cost and higher operating cost.

Obviously it is not fair to charge the first customer as much as the second, so the operating company says to the customer, "We'll charge you a certain rate per kw.-hr. consumption, and a fixed charge based on your maximum demand." For instance, 3c. per kw.-hr. for energy consumed and $2 per month for every kilowatt of the maximum demand that occurs during any hour of the month.

This rate would cost the first customer $2160 for consumed energy per month plus $200 for a maximum demand of 100 kw., making a total monthly bill of $2360. The second customer's bill would be $2160 for energy consumed plus $600 for a maximum demand of 300 kw., making a total of $2760. This extra $400 represents the cost of interest, etc., on the increased capacity required and the cost of keeping the fires burning and engines running ready to serve the customer at any instant.

This is only a moderate example. Some installations such as rolling mills, or electric cranes or hoists or mine equipment, insist on drawing a heavy load for only 5, 10 or 15 min. out of every hour and remaining idle the remaining time. To compensate for this, maximum demand charges are often based on a range varying from a one-minute maximum charge in one extreme case to a 4-hr. charge at the other extreme.

Charges below one-half or one-quarter hour, however, should be viewed with suspicion unless a careful investigation discloses their fairness, as it is an unusual case where the generator will not withstand a maximum load or a moderate overload without overheating for at least a half-hour.

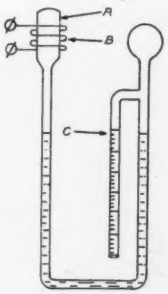


FIG. 1. SCHEME OF THE WRIGHT MAXIMUM DEMAND METER

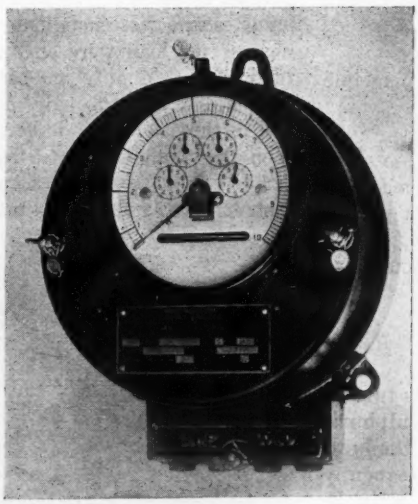


FIG. 2. SINGLE-PHASE AUXILIARY DISK DEMAND METER

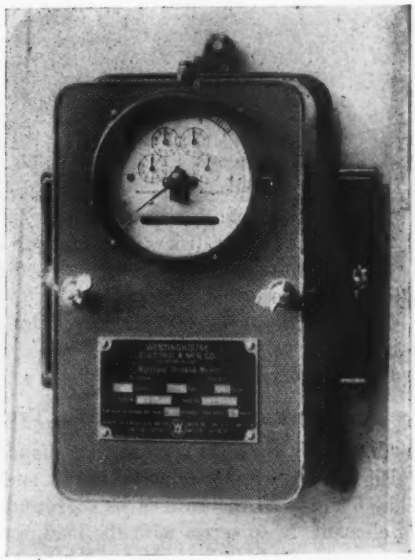


FIG. 3. POLYPHASE AUXILIARY DISK DEMAND METER

Maximum Demand Meters

It is the function of the maximum demand meter to record the maximum load which occurs during the month, at any interval for which it may be set. Demand meters classed according to the character of service rendered are: (1) maximum current indicators (now practically obsolete); (2) block demand indicators, and

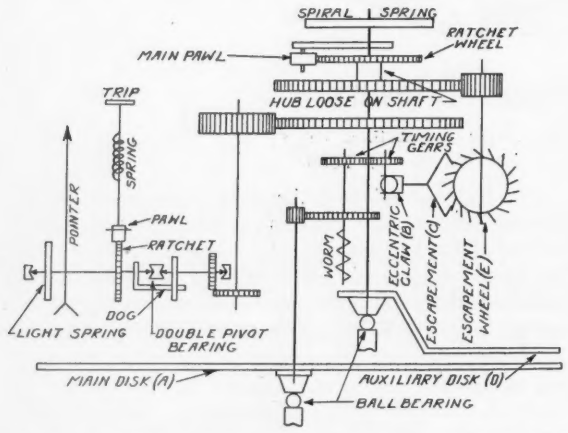


FIG. 4. SCHEMATIC DIAGRAM OF METER WITHOUT DIAL MECHANISM

(3) thermal demand indicators. Classed as to principle of operation they are:

1. Liquid overflow caused by a heated strip.
2. The induction demand indicator.
3. The auxiliary disk with watthour escapement.
4. The contact making register used with a printometer, visual recorder or graphic.
5. The graphic with pen driven by watthour gear train.
6. The thermal storage meter.

The Wright Thermal Type

The first type consists of a V-shaped glass tube as in Fig. 1, containing a heavy liquid such as sulphuric acid. The top of the bulb, A, is surrounded by the heating element, B, in series with the load, and consequently the expansion of air in A due to the heat of the strip, B, forces the liquid into the overflow tube, C, and the height of the liquid in this tube is a measure of the maximum demand in current but not in actual watts.

The Induction Type

The induction type responded to the actual watts, but had the disadvantage that its indication was much greater over the first portion of the interval than over the last. For instance, assuming a 15-min. interval, with a constant load, the maximum demand pointer would reach 90 per cent of its final deflection in 4 min., 95 per cent in 6 min., 99 per cent in 10 min., and 100 per cent in 15 min.

In construction, this instrument has a moving element quite similar to that of the polyphase watthour meter. Both actuating elements, however, drive the upper disk while all the damping is done on the lower disk. The motion is opposed by spiral springs allowing the disks to turn three revolutions in the rated time interval at the full load. Three revolutions cause full scale deflection on the dial. This meter has two pointers, one geared directly to the moving element and one with a ratchet which is moved upward only by the first pointer and so indicates the maximum position to which the first pointer has traveled. It is easily reset to zero at each meter reading.

Auxiliary Disk with Watthour Escapement

This meter is one of the most difficult to understand, as it gives an accurate time without the use of auxiliary damping magnets or time clock works. Its general appearance is shown in Figs. 2 and 3, while its principle of operation is shown in Fig. 4.

It consists of a main disk, A, which records the total kw.-hr. consumption on a standard integrating dial and also works eccentric B and escapement claw C at a speed proportional to the speed of the main disk. There is also an auxiliary disk D actuated by the same electromagnetic system as main disk A, and this disk tends to deflect the pointer over the maximum demand dial. It is restrained from instantaneous deflection, however, by escapement wheel E, and the rate of escapement is so proportioned that the pointer reaches its maximum deflection in the rated interval of the meter.

For example, if the auxiliary disk tends to deflect the pointer to 500 kw., then the speed of the main disk will let E escape fast enough to reach 500 in., say 15 min.; now, if the load were only 250 kw., the pointer would tend to deflect only one-half as far, but as the main disk is now running only one-half as fast, it will reach 250 in the same time as before. If the load is 125 kw., then the tendency for deflection is only one-fourth as far and as the speed of escapement is only one-fourth as fast, it follows that the time is still the same as in the

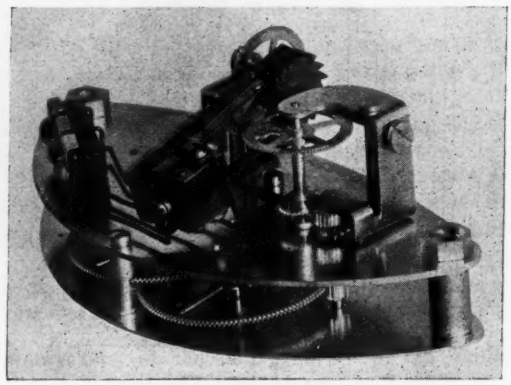


FIG. 5. CONTACT MAKING REGISTER

previous type; the indicating pointer pushes an auxiliary pointer over the scale and as this auxiliary pointer moves only forward and not backward due to the ratchet, it indicates the maximum distance to which the indicating pointer has traveled.

These indicators are satisfactory where the maximum load extends steadily over the rated interval as for instance in a silk or cement mill; but they are totally unsuited for the measurement of a maximum demand which fluctuates rapidly during the interval. For instance, if we have a load of 500 kw. for 7 min., no load for one minute, 500 kw. for 7 min., etc., the actual maximum demand for 15 min. would be 462 kw., but

this meter would indicate only 250 kw. This is because there is no time lag on decreased load and upon the least interruption to load, the maximum demand pointer returns instantly to the lower reading instead of returning in 15 min.

The Contact Making Register

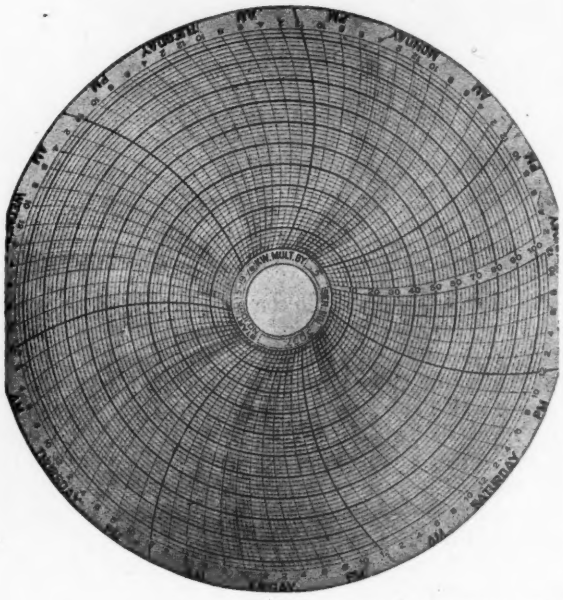
The use of a standard watthour meter to record the kw.-hr. consumption with contacts on the register to operate an auxiliary instrument and so give the maximum, has found considerable favor for a number of years. A view of this contact-making register is shown in Fig. 5. Every time the watthour disk makes a certain number of revolutions, it closes the contacts and these contacts close the electrical circuit to either a visual indicator, printometer or graphic meter. In the visual indicator, every time the register closes the circuit, it advances the pointer one division and every 15 min. or other definite time interval, a separately timed mechanism returns the pointer to zero. The secondary ratchet pointer thus gives an indication of the maximum number of closings in any 15-min. block.

The time is obtained by a simple disk induction motor which is permanently connected to the potential and revolves at constant speed. After a definite number of revolutions it releases the pointer.

In the printometer type, every time the meter register makes contact, it advances a cyclometer dial one number and every 15 min. or other definite interval of time, an ordinary clock makes contact to a strong solenoid which prints the cyclometer reading on a strip of paper tape.

The maximum demand is obtained by subtracting each reading from the one following and multiplying by a constant. This tape gives the distinct advantage that not only the maximum demand, but also the time of its occurrence, can be determined from the tape. It has, however, two disadvantages: (1) It takes about 2880 subtractions to figure out a month's demand on a 15-min. interval tape, for only one meter and where there are a number of meters, the clerical work is excessive; (2) cases have been known where a chattering or double making of the contact on the register have advanced the wheels entirely too far, resulting in an excessive maximum demand.

To eliminate the excessive figuring, the contact making register may be used with a graphic, so that every contact moves the pen forward one division and at every interval of rated time, the pen is reset on zero and the paper advanced a slight amount. Typical records of both tape and graphic are shown in Fig. 6.



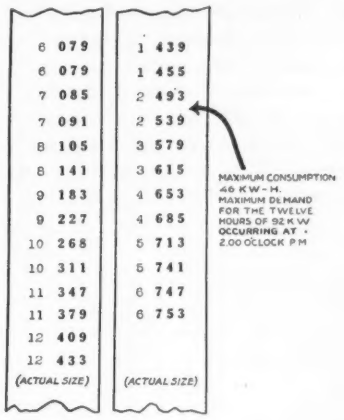


FIG. 6. TYPICAL GRAPHIC AND TAPE RECORDS

Demand Meter with Mechanically Driven Pen

One of the most successful meters used in the measurement of maximum demand is the meter shown in Fig. 7. This gives a registration of the total kilowatthour consumption on the regular gear train dial and gives a graphic record of the actual demand during every 15 min., half-hour or hour interval, and from this chart the maximum demand is easily picked out by noting the highest point to which the pen recorded.

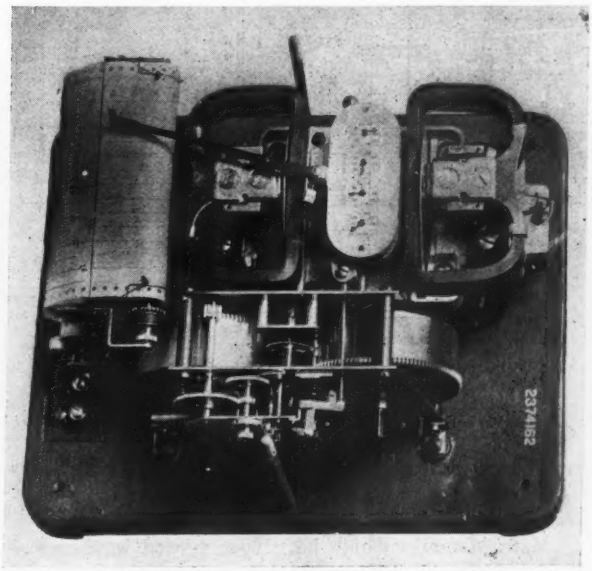


FIG. 7. DEMAND METER WITH MECHANICALLY DRIVEN PEN

This kind of a record is often most important in case of discrepancies where the customer disputes the occurrence of the demand charge. Instead of the electric company saying that their instruments showed a certain demand sometime during the month, they can actually produce the chart and give the exact date and time of day at which the demand occurred.

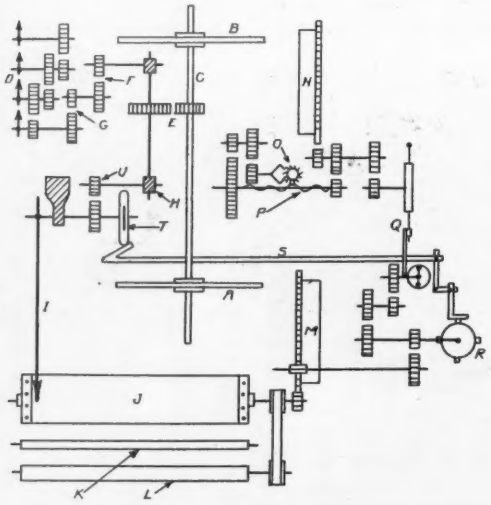


FIG. 8. SCHEMATIC DIAGRAM OF PARTS OF THE MECHANICALLY DRIVEN PEN

Many disputes which have been settled in this way have brought to light certain abnormal conditions in the plant which would not otherwise have been suspected.

In Fig. 8 is shown the schematic diagram of parts of this meter. There are two disks, A and B, which are rotated by the two elements in the polyphase meter. These rotate shaft C and record the kilowatt-hour consumption on gear train D through gearing E, F and G.

Also geared to the first wheel from the shaft is worm gear H which moves pen I across paper roll J, a distance proportional to the watthours or the revolutions of the disks. The paper is fed over roll J from roll K and rewound on roll L.

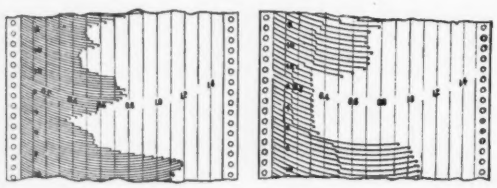


FIG. 9. SAMPLE RECORDS OF A 15 AND 30-MIN. CHART

At the right-hand side of the meter is a high grade clock with two main springs M and N. The function of spring N is to keep perfect time and release the power of spring M at definite intervals and this spring moves the paper. Spring N is provided with watch escapement O and spring tension governor P. This governor is so arranged that spring N winds it up to a certain tension and locks; then when the tension decreases, due to the escapement of the balance wheel, it again releases and the main spring again winds it and locks. In this way isochronal time is obtained over a period of at least 35 days on one winding.

Every 15 min. pin Q releases the escapement on the lower mechanism and spring M causes the paper to rotate 1/16 in. and turn cam R one-quarter of a turn. This cam causes rod S to move sidewise and this raises rod I and wheel V, thus throwing the pen out of mesh with the watthour gear train. The pen returns to zero where it is automatically inked, and is then thrown back into mesh at U and again commences its upward travel for another interval.

By removing screws in R, the meter may be changed to a ½-hr. or one hour interval although the gearing must also be changed accordingly. Sample records of a 15-min. interval and a 30-min. interval chart are shown in Fig. 9.

THE THERMAL DEMAND METER

DURING RECENT YEARS the complaint has been made that a maximum demand charge based on a kilowatt-hour block demand is not correct, as the maximum demand charge is supposed to compensate for the increased generator capacity necessary. The capacity of a generator is usually limited by its maximum heating, and as this heating follows a logarithmic curve, it is argued that a meter which also gives a deflection similar to a logarithmic curve should also be employed. The meter shown in Fig. 10 gives this kind of a scale as it operates on the thermal storage principle. As shown in Fig. 11, there are two bi-metallic springs, A and B, wound in opposite directions and rigidly connected to shaft C. To this shaft is also attached pointer D which gives the maximum indication either on a graphic chart or a ratchet pointer.

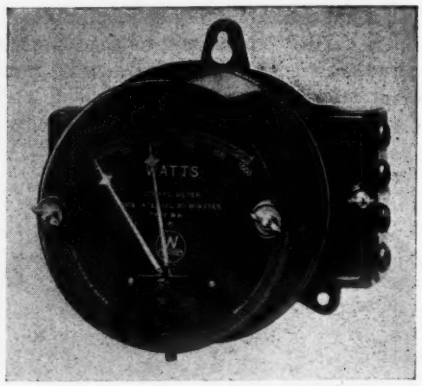


FIG. 10. THERMAL DEMAND METER

There is a small transformer with a current winding E and a potential winding F. The current winding is in two parts each of which is connected in series with a heater winding around bi-metallic springs A and B. Upon the occurrence of powerflow in the line, there will be unequal heating in the two heater windings F and G and this difference in heat can be proved mathematically and demonstratively to be proportional to the true watts expended in the circuit.

Size and radiation surfaces of these heaters, springs and enclosing boxes are so proportioned that they reach their maximum temperature in 15, 30 or 60 min. according to the design of the meter.

The greatest objection to this meter is the working of its terms of deflection into a power contact as in general the average business manager of the industrial concern is but little acquainted with electrical terms and in using this meter it generally becomes necessary to educate the user so that the fairness of its charge will be readily apparent. Another objection is that it must be used in conjunction with a watthour meter and the psychological effect upon the customer is that he is paying more with two meters than with only one.

Reactive Component Measurement

In the discussion so far we have assumed that the meters have been used only in the maximum demand measurement of true watts; but in actual practice, the customer is often penalized for low power factor, and the best way to get this is to provide two meters, one of which is connected to measure the true watts and the other is connected to measure the reactive component.

If two meters like Fig. 7 are employed, their registration gives the following results:

1. Total consumption in kilowatt-hours.
2. Total consumption in reactive kilovolt-ampere-hours.
3. Total consumption in kilovolt-ampere-hours. (This is the square root of No. 1 and No. 2.)
4. Average power factor (No. 1 ÷ No. 3).
5. Maximum demand in kilowatts.
6. Maximum demand in reactive kilovolt-amperes.
7. Maximum demand in kilovolt-amperes.
8. Minimum power factor.
9. Also the exact time of occurrence of points No. 5, 6, 7 and 8. From this it will be seen that the record is complete and although this constitutes a high initial investment in meters, yet when the bill amounts to several thousand dollars per month it is quite apparent that nothing but the highest accuracy and most reliable equipment will give satisfaction to both supplier and consumer.

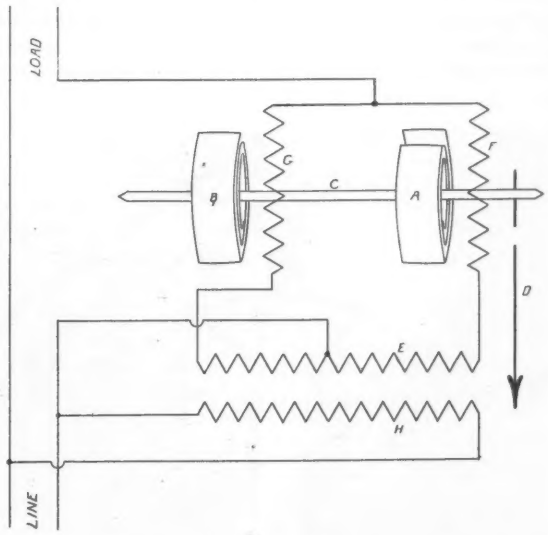


FIG. 11. DIAGRAMMATIC SCHEME OF THERMAL DEMAND METER

Power Transformers

Types; Considerations of Design Essential to Satisfactory Operation; Maintenance Hints. By C. L. Knotts*

POWER TRANSFORMERS may be divided into two classes with reference to the method employed in insulating and cooling, namely the air blast and the oil immersed. The chief advantage of the former over the latter is that it requires less floor space. For voltages above 22,000 this advantage disappears, and the oil immersed transformer is favored from the standpoint of cost. Floor space and cost, however, are not the only considerations, since in certain cities the insurance authorities require that oil immersed apparatus be installed in fireproof compartments. Hence, the use of air blast transformers has been restricted to relatively low voltages, and for the most part to installation where the presence of oil is objectionable.

On the other hand, the oil immersed transformer is suitable for the highest operating voltages and has a distinct advantage over the air blast type in its greater short time overload capacity. This characteristic is extremely important at the time of failure of the cooling medium. The oil employed is a highly refined mineral oil, free from moisture, acid, alkali and sulphur compounds; it has a high dielectric strength as well as a high flash and fire point; and while it serves materially in strengthening the insulation, it is also the medium by which the heat generated in the transformer is carried to the cooling fluid.

Methods of Cooling Oil

According to the means used for cooling the oil, this class of transformer is divided into self-cooled and water-cooled types. Since, in the former type the amount of loss which can be absorbed by the air depends almost directly upon the surface of the container exposed to both air and oil, special means have been taken to increase the surface area of the container. This has resulted in two separate types of containers, namely, those with corrugated sides of thin sheet metal, and those with external radiators, with or without the corrugated tank wall. The former type of container can be used only for ratings up to approximately 1500 kv.a., while the latter covers ratings as high as 10,000 kv.a. By means of a blast of air properly directed, the effectiveness of radiating surface may be practically doubled. This has given rise to the more recent type of transformer, known sometimes as the oil insulated air blast type.

The water-cooled transformer requires much less floor space than the self-cooled type inasmuch as the active materials in the transformer may be worked to a higher degree without the loss of economy and because the cooling coils are immersed in the oil above the transformer. Some water is unsuitable for circulating in cooling coils on account of its corrosive effect on all known commercial cooling coil materials. On account of the danger to the transformer resulting from this effect, the force-cooled

* Of the transformer engineering department, Westinghouse Electric & Manufacturing Co.

transformer has been developed. In this type, the cooling pipes are externally located with respect to the transformer container and the hot oil is circulated through the cooler by means of a pump. In this way, it is possible to maintain a higher static pressure on the oil side of the pipes than on the water side. Thus, when a break in the cooling coil occurs, the water cannot leak in the oil.

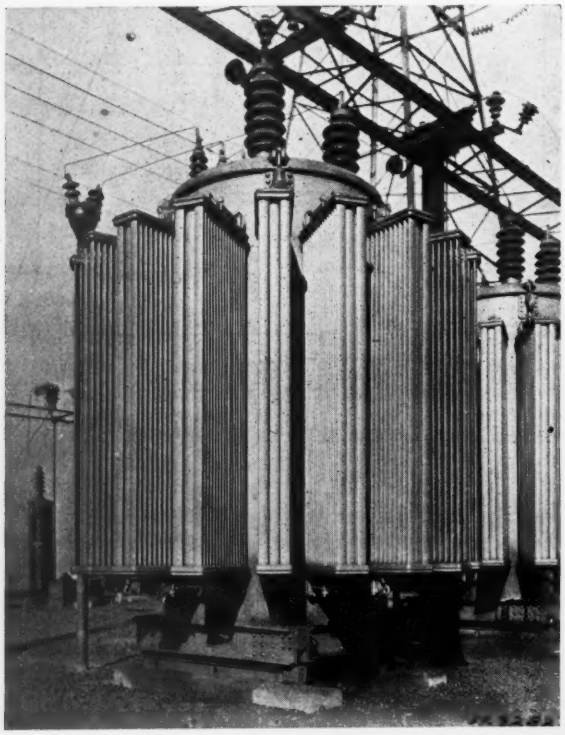


FIG. 1. TYPICAL 8333-KV.A. SINGLE-PHASE 60-CYCLE SELF-COOLED TRANSFORMER

TRANSFORMER TYPES

ACCORDING to the relative arrangement of coils and iron, all transformers may be further classified as either core or shell type. In the former, the coils surround the magnetic circuit and in the latter the magnetic circuit surrounds the core. This statement in itself would indicate that the shell type transformer requires a greater amount of insulation from iron than does the core type. And it is a well-known fact that relatively small capacity, high voltage transformers show greater economy as core types than as shell types, whereas all relatively large transformers show greater economy as shell types. The choice between shell and core is often influenced by the many considerations.

With the rapid growth of power systems in the last few years the danger of severe short circuits has become apparent. As regards the means for minimizing the danger due to short circuit currents, two considerations are fundamental; first, these currents must be limited to such a value and of such duration as not to cause injurious heating; second, all current carrying parts must be mechanically strong enough to prevent permanent distortion.

The former consideration has been met by higher reactance values and by quick-acting circuit-breakers. Higher reactance materially reduces the rate of heating in the circuit and at the same time allows the use of a smaller circuit breaker. The latter condition has been met by thorough methods of bracing and support. Electrical conductors are subject to two separate mechanical stresses. Between conductors or groups of conductors carrying current in the same direction, the force is attraction; while between conductors or groups of conductors carrying current in the opposite directions, the force is repulsion. Hence, within groups of high or low voltage coils, the tendency is to draw the outer conductors toward the center of the group and between groups of high and low voltage coils, which carry currents in opposite directions, the tendency is to move apart. The magnitude of short circuit stresses increases in proportion to the square of the current. Where the power system is of sufficient size to maintain approximately normal voltage during the period of short circuit, the stresses often amount to many tons.

Short circuit stresses must be considered from two standpoints; first, the bracing of individual conductors, and, second, the bracing of groups of conductors. The first is intimately related to the matter of ventilation, as the ideal arrangement would be to brace all conductors

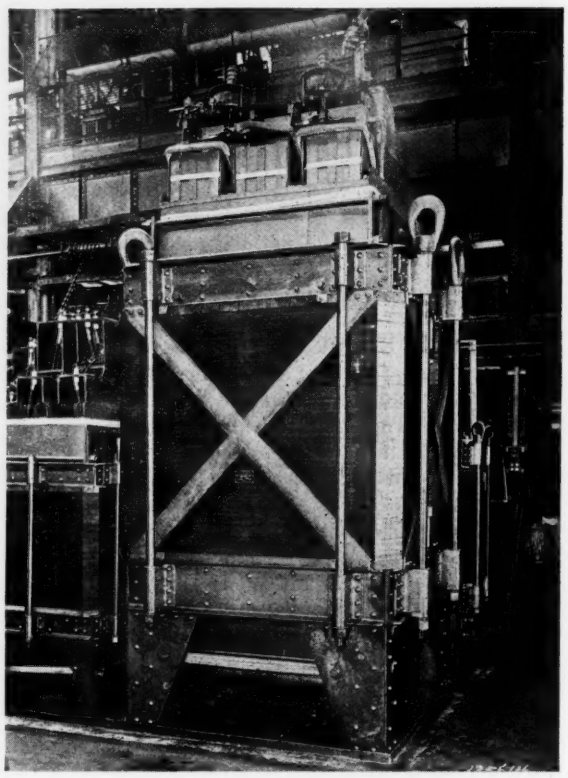


FIG. 2. WATER-COOLED TRANSFORMER RATED AT 23,600 KV.A., SINGLE PHASE, 60 CYCLES

throughout their entire length. Satisfactory results, however, have been obtained, (1) by using conductors which are wide in the direction of the stress, (2) by supporting all conductors at short intervals, and (3) by treating the coils before assembly with impregnating compounds which bind all the conductors into a solid mass. The second has to do mainly with the magnitude of the stress.

In core type transformers having one winding inside the other, the stresses between primary and secondary are radial under ideal conditions, and tend to increase the diameter of the outer coil and decrease the diameter of the inner coil. If the coils are circular in form, radial forces will be taken care of by the copper itself. Due to manufacturing variations, however, the magnetic centers of primary and secondary windings has a more or less indefinite component, depending on the actual displacement of magnetic centers, tending to force one coil upward and the other downward. This type of winding is usually braced against the upper and lower end frames. It has sometimes proved inadequate because of the small area of the winding in contact with the bracing.

Shell type transformers need to be braced only at the ends where they extend beyond the iron. The iron circuit, with its lap joints, when properly clamped, forms a very substantial brace for that part of the coils which they surround. The shell type differs from the core type in that it exposes a large coil surface to the bracing members. These consist of boiler iron plates held rigid by tie bolts through the ends. In addition to this bracing the coils are braced against upward or downward movement by tee beams above and below the iron circuit

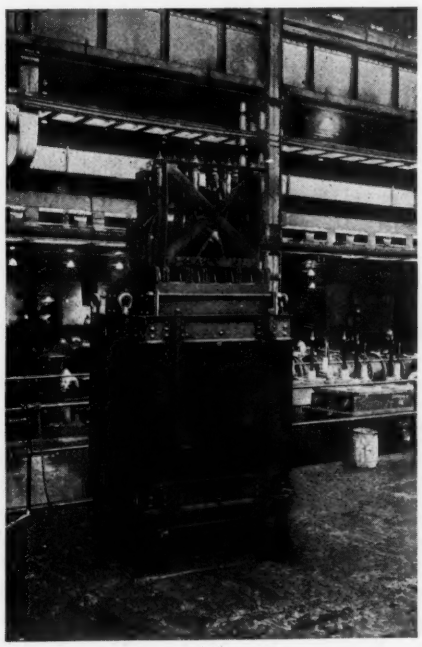


FIG. 3. SELF-COOLED SHELL TYPE TRANSFORMER

inside the coils. These beams are held apart by a toggle bolt. See Fig. 2.

Further, with respect to the assembly of the iron circuit the core and shell types are essentially different. In the former type, the sheet steel laminations are assembled and permanently riveted together in such a way that the assembled coils may be lowered into place. The yoke is then put on so as to make a lap joint. Butt joints, with assembled yokes, have been used to facilitate in making repairs. This practice, however, has not become general on account of the difficulty of assembling the punchings so as to eliminate local heating. In the latter, or shell type, the assembled coils are set in the end frames and the punchings are all built in with lap joints. This process does not take appreciably more time than the assembly of the yoke in core type transformers, and it is far less difficult.

There is a further complication in the case of large core type transformers, for in some cases it is necessary to ventilate the widest punchings. This feature is never resorted to on shell type transformers, as the iron circuit is composed of narrower sheets with oil free to circulate on one side. In the case of air blast transformers which are practically always shell type, it is sometimes necessary, however, to furnish ducts around the inside

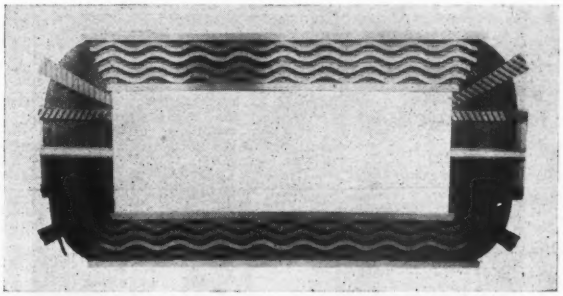


FIG. 4. SHELL TYPE TRANSFORMER COIL

of the iron circuit outside the coils so as to cool both edges of the laminations.

Protective Devices

Inasmuch as continuity of service is now more highly valued than ever before, the demand for protective devices has been continually growing. Among these devices, the temperature indicator for oil immersed transformers is undoubtedly the most important. Since the oil temperature in this class of transformers does not respond readily to changes in load, while coil temperature follows changes in load closely, it should be apparent that a transformer may be subjected to dangerous temperatures while the oil temperature indicates that the apparatus is operating under safe conditions.

Temperature indicators are of several different types of which perhaps the simplest is the thermo-couple. This usually consists of a junction between copper and advance metal, the characteristic of which is that it generates an electromotive force proportional to its temperature. This electromotive force, or thermal electric voltage, is measured by a potentiometer reading in degrees. A slightly different type of indicator consists of a small resistance element whose change in resistance is a measure of the temperature. Both of these types are located as close to the hottest part of the transformer winding as is possible, but their weak point lies in the fact that they must be insulated from the windings, and therefore cannot indicate the true hot spot winding temperature. This objection has been overcome to a certain extent by another type of indicator, the element of which is wound between turns of the coil located in the hottest oil; however, it is not always desirable for such devices to be so intimately related to the transformer windings; for this reason, another type of indicator has been developed.

This more elaborate temperature indicator consists essentially of a current transformer which supplies a

current proportional to the load current to a small heating coil which accurately reproduces the thermal conditions in the main transformer windings. The heating coil is located in the hottest oil, where it is easily accessible. The indicator element may be either a resistance coil, in which case it is intimately related to the heating coil, or it may be a thermometer bulb. The former is more convenient for long distance indications, although in the case of the latter, alarm contacts may be utilized to warn of dangerous winding temperatures. An important feature of this indicator is that it may be calculated from the factory test so as to indicate a true hot spot temperature.

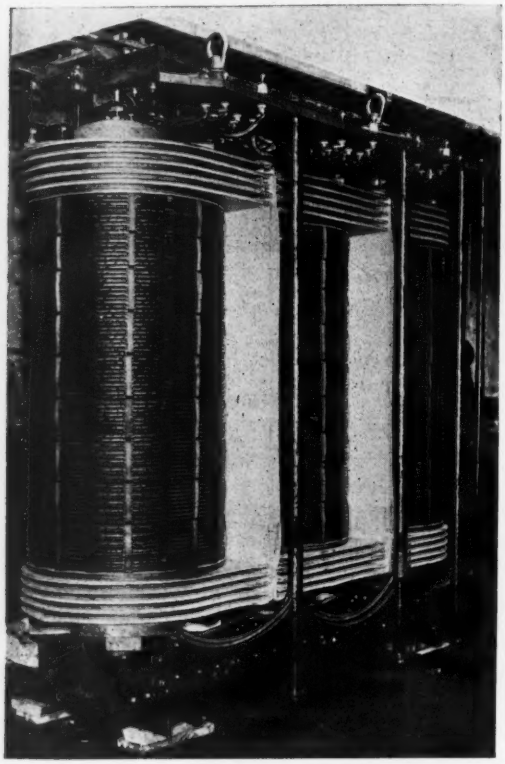


FIG. 5. THREE PHASE CORE TYPE TRANSFORMER RATED AT 3000 KV.A.

The demand for these indicators has not yet reached the air blast transformer, although a thermostatic, or bimetallic, strip has been employed to close alarm circuits or to operate relays which close the dampers and open the primary breakers in case of excessive outlet air temperatures. Along this same line, an air pressure relay has been developed to give an indication of low air pressure.

For outdoor installations of water-cooled transformers, where a transformer may be required to lie idle in freezing weather, gravity drained cooling coils are an important consideration. In some cases, these are made in such a way that the transformer may not be removed without first removing the cooling coils. This arrangement is not favored, however, as it also necessitates removing a considerable portion of the oil.

Choice of material for cooling coils should also be considered from the standpoint of offering the greatest possible protection to the transformer. Much of the water used in transformer cooling coils contains scale forming impurities which clog the coils and interfere with the proper cooling of the transformer. In some cases, impurities attack the material itself, eventually destroying the coils. Copper is the material best suited to minimize such troubles, but there is no commercially available material which is impervious to salt water.

The use of expansion tanks has been advocated by some manufacturers as a means of protecting transformers from explosions due to the accumulation of gas in the top of transformer tanks, above the oil. They are often, however, applied as a protection to the oil in the main transformer tank. In this respect they are said to serve a twofold purpose, the first being to preserve the oil from excessive sludging and the second being to trap as much water as possible absorbed in breathing and thus preserve a high dielectric strength oil in the main tank.

Excessive sludging usually occurs only when hot oil is exposed to the atmosphere. The expansion tank is connected to the main transformer tank by a small pipe and the temperature of the oil in it is, therefore, only slightly affected by the hot oil in the main tank. The breathing action referred to takes place when the transformer oil expands or contracts due to changes in temperature. In many cases, chloride breathers are supplied to remove the moisture from incoming air. But for any moisture which finds its way into the oil, a sump is sometimes provided in the bottom of the expansion tank inasmuch as the greater part of such moisture collects in the lower part of the container.

MAINTENANCE HINTS

AS IMPORTANT as all such protective considerations are, however, they are not in themselves capable of preventing failures. Of far more importance is the proper care of the apparatus. This consists of making frequent and regular inspections and in taking certain necessary precautions. Among some of the more important things to be considered, are the following:

Intakes of blowers supplying air to air blast transformers should always be thoroughly screened. Yet, in spite of screens a certain amount of dust will be deposited in the ducts of the transformer. This dust should be cleaned out with a felt swab or blown out by dry compressed air. The frequency of these cleanings should be governed by the amount of dust in the atmosphere.

Cooling coils which have appreciable scale deposited in them do not pass their normal flow of water and likewise are not as effective in removing heat from the transformers. Wherever this scale forms, it may be blown out with live steam or loosened by filling the cooling coils with a weak solution of hydrochloric acid. After the latter has been allowed to stand a short time, the coils should be flushed thoroughly with pure water.

When cooling coils are subject to corrosion, they should be removed from the transformer frequently and tested with an hydraulic pressure of several hundred pounds, depending on the frequency of the tests.

Since the oil plays a vital part in the operation of an immersed transformer, it should be cared for accordingly. Samples should be taken at frequent intervals and given dielectric tests. If such tests indicate the presence of moisture in any appreciable quantity, the oil should be filtered at once.

In this connection, it is well to note that chloride breathers may be responsible for much moisture finding its way into the oil if they are not properly inspected, and the contents renewed if necessary. The frequency of renewals will depend entirely on the amount of moisture in the atmosphere and upon the amount of breathing which takes place.

Transformers should be opened up at least twice a year and a careful inspection made of the core and coils. The coils and coil bracing should be examined for any signs of serious distortion. In the case of oil immersed transformers where a poor grade of oil is being used or where the transformer may have been operated at

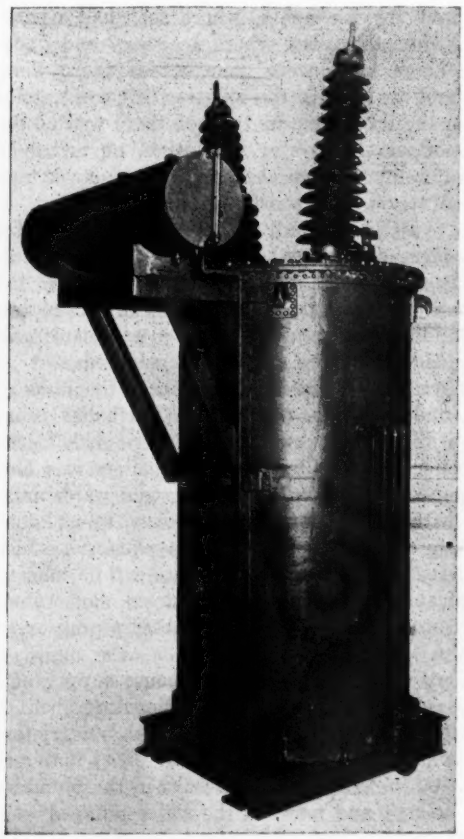


FIG. 6. 5000-KV.A. SINGLE-PHASE WATER COOLED TRANSFORMER

unusually high temperatures, a black deposit may cover the top of the transformer as well as the cooling coils. These should be wiped with clean, dry waste. The outlet leads and the terminal supports should be examined from above and below for any evidence of deterioration or breakage. All nuts should be pulled up as far as they will go. Before returning oil immersed transformers to their cases, these cases should be wiped out with dry waste and the oil filtered and dehydrated if necessary. If the transformer has been exposed to damp air, the insulation resistance should be taken to determine whether or not it is necessary to dry the transformer before putting back in service.

Overloads for which a transformer is not designed should not be permitted. Unless there are temperature indicators or special temperature coils, it is not possible to tell the thermal condition of the windings at such times. For overloads that continue for an appreciable length of time, the maximum oil temperature in oil immersed transformers and the maximum outlet air temperature in air blast transformers are fairly reliable indications of the winding temperature. It should be borne in mind that the winding temperature is always higher than either by an amount which varies roughly with the square of the load.

When transformers are originally installed, measurements of air volume in air-blast transformers and of water in water-cooled transformers should be made, and dampers and water valves plainly marked for not less than the required amount of cooling fluid. Under normal full load operating conditions, the outlet air temperature of an air blast transformer should not exceed the inlet air temperature by more than approximately 15 deg. for maximum continuous operation. Likewise, in water-cooled transformers the oil temperature should not exceed the temperature of the ingoing water by more than approximately 35 deg. C. for maximum continuous operation. In the case of self-cooled transformers, the oil temperature may exceed the outside air temperature by as much as approximately 45 deg. C. Temperatures appreciably in excess of these values, except for special designs, indicate either an overload or subnormal cooling. The latter can be checked.

Overvoltages in excess of five per cent should not be employed, unless provision has been made in the design of the transformer for such a condition; this for three reasons. First, it decreases the factor of safety of the insulation. Second, it considerably increases the exciting. Third, it usually increases the operating temperature of the transformer. Ordinarily, 10 per cent over voltage will double the exciting current of a transformer, and, depending on the design, may increase the temperature rise by resistance as much as ten per cent for normal power output.

The importance of transformer temperatures is now so well recognized that most operating companies include temperature readings as a part of the station record, and some even go so far as to install recording thermometers.

Another Objection to Charging with A. C.

SCIPIO, the assistant fireman at the power house had bought a new flivver. His friends thought it strange that anyone claiming to be the great electrician that Scipio did should purchase a gasoline car whereas, as they figured it, he could charge his storage battery free; therefore it logically seemed that he should have purchased an electric.

"Well, well, Scipio, I'se sprised dat yuse gits a benzine buggy when yuh mighta got a 'lectric and yuh chargin' current free."

"Pos'bly so, pos'bly so, but ovah at our plant de current am all alternatin' and I'se hyar to tell yuh right now dat if I was to charge mah battery wif alternatin' current, dat de car would run three feet fo'ward, three backward, get me nowhah and jist jerk mah damn head off. Dat's de answer to yer riddle."

J. B. DILLON.

A MALCONTENT is like a gloomy day—everybody wants it to clear out.

The "Inner Works" of a Hotel

A Method of Analyzing the Condition of a Hotel Power Plant. By George Talcott Ingersoll

ABOUT THREE years ago, I shared a seat on a crowded train with a New York man whose business was hotel kitchen equipment. He was not in a happy frame of mind; the night before he had paid for a room and bath at a modern hotel, but he did not get any water. He wanted to tell me his troubles, and, in doing so, he also told me many interesting things about hotel kitchens and power plants.

This man had a beautiful watch that he looked at so frequently as to attract my attention. I saw he was very proud of it and I finally asked permission to examine it. The case was 14-karat gold, beautifully engraved, with monogram on one side and diamond setting and emblems on the other. I remarked:

"That is a beautiful case. There must be a very fine movement inside to correspond with such an excellent case."

"You are right," he replied, "the movement is of the highest grade, 23 jewels with all adjustments. I wouldn't have any other kind of movement."

My companion soon left the train, but the incident of the hotel and the watch did not leave my mind and the thought came to me: A fine watch is like a modern hotel. It has a beautiful and costly case and a movement or inner works to correspond. So it must be with the fine modern hotel with its beautiful exterior and costly lobby; the inner works or power plant must correspond.

Something occurred every few days to recall this incident, and I finally decided to do a little investigating on my own account. For the past 3 yr., therefore, as a diversion from other work, I have secured from various sources some data on the subject and have made brief analyses of hotel power plants. Naturally, during this investigation, I saw and heard many interesting things, some of which I will briefly describe.

I am sure these conditions exist in only a few large hotels. I do not mention them in a spirit of useless criticism, but with the hope that my remarks may start some constructive thinking on the part of those directly interested in hotel operation, both managers and power plant men.

Things I Have Seen

I HAVE SEEN plastering torn away in many places for the purpose of locating troubles in concealed piping. Perhaps the trouble had been repaired, but the plaster had not been replaced. Does concealed piping make for utility, simplicity and efficiency in a hotel or is there a better way?

I have seen large, modern hotels with no pneumatic tubes, no dumb waiters, no mechanical conveyors, where all transfer work within the hotel was dependent upon common labor, hand trucks and freight elevators, which were frequently out of commission.

I have seen the crudest and most wasteful firing of boilers with no check on any of the factors which make for efficiency except a cheap steam gage which had never been tested. The hotel bought the cheapest coal to be had, which was a mixture of coal, ash and dirt; this was dumped down in "The Hole," and it was up to the boys there to shovel enough into the boiler to keep up steam.

I have seen water for hotels taken from drilled wells by the cheapest kind of air lift where the same work could be done better by motor driven pumps at about one-quarter the cost.

I have seen water-tube boilers using bad water cleaned about once in three months where the scale was nearly ½ in. thick in the tubes and the header gaskets were unfit for use again, where soot had never been cleaned from the tubes, where necessary and important parts of the baffle were gone, where there were bad cracks and air leaks in the boiler setting walls, holes and leaks in the breaching, and where there was no damper regulation, no feed-water regulation, no meter on the feed water line and no check on CO_2 or stack temperature. A steam gage constituted the equipment.

I have seen homemade oil burners in use under water-tube boilers and have been told by the engineer that anybody could make a burner. "All you have to do is to take a piece of pipe." This must have been a single-track mind. The idea was to keep up steam; cost and other incidentals were not to be considered.

I have visited power plants where the leaks of live steam under 125 lb. pressure in the boiler room and kitchen might easily run into $1000 or $2000 per year. The boiler room ceiling near the boilers was obscured by a network of steam, hot water, cold water and other pipes with no platform and no way to make repairs except to use a ladder or build a platform, which was considered too much trouble. There was no color scheme to indicate live steam, exhaust steam, hot water, cold water, ammonia, brine, sewer or other piping or electric conduits.

In some cases water for the house supply of hotels was pumped to tanks on the roof against about 250 to 300 ft. total head, 40 or 50 ft. of which was friction loss. This same water used on the lower floors under a pressure of 60 lb. to 80 lb. caused leaks in the plumbing and other fittings, and much of the water pumped went into the sewer.

The "Out of Order" sign is too frequently seen on both passenger and freight elevators, and often happens at a time when they are most needed.

Surely the managers of large hotels are good business men. This must necessarily be so else they would not long be managers. But perhaps many of them have little practical knowledge of power plant machinery and its efficient operation; at the same time, they feel that they must keep a tight rein on the expenses of that department. It may also be that the chief engineer is not able to present in convincing form, figures of needed changes or new equipment, the use of which would result in savings sufficient to repay the cost in one or two years.

Perhaps the average hotel manager is so busy with his own particular work that he has no time to exchange ideas and experiences with other hotel managers, or with the heads of the various departments in his own hotel. It would seem that each hotel manager would want to

know, at the end of each 24 hr., whether his power plant in every detail has been running at normal efficiency, or, in other words, whether the whole plant is in tune; if there is much change or variation in the work of the whole plant which might mean waste or loss, he would want to know how to locate it so as to stop the loss. If he had detail operating costs in dollars and cents, he might more quickly detect changes.

I cannot at this time go into detailed explanation of this; it is an interesting subject of itself and very important in the elimination of loss.

The "Inner Works"

Machinery combinations in modern 500 room hotels are many and perhaps no two hotels are alike, a condition which must be so to suit local circumstances. For the present, I shall assume that the water supply comes from a drilled well; that there is no laundry in the hotel; and that electric current is bought from a power company. Without going into details, the inner works or power plant would include the following equipment:

A drilled well with air lift or pump. Steam boilers and fuel handling machinery, heaters, steam engines, ammonia compressors and refrigerating apparatus, air compressors, ventilating equipment, tanks, piston and centrifugal pumps for water or brine, a.c. and d.c. motors, transformers, switchboards, freight and passenger elevators, a lighting system and a variety of small electric driven equipment. Special cooking and baking apparatus using either steam, gas or electric current, and a network, extending throughout the building, of conduits for electric wires, of steam, hot and cold water, sewer and drainage pipes would also be included. This collection of equipment makes up the inner works or power plant of the hotel. It must be kept going 24 hr. a day, 365 days a year, and must take care of sudden and extreme changes in weather and many extra or special guests who come with conventions, excursions, tourists or for banquets. Unlike the great majority of industrial power plants, there is no Sunday rest for inspection and repairs. Sunday may be the busiest day of all.

Chief engineers of such power plants have a responsible position. The safety and comfort of thousands of guests depend upon his skill, foresight and judgment. He has not only to please cranky guests, but must keep peace in the whole family of employes around the hotel, many of whom are largely dependent upon power plant equipment for their work.

What interested me in this investigation, and what I have thought would also interest hotel managers and power plant men in general, is not a set of technical efficiency tests on various machines, but on the contrary, a scheme of analysis or mental inventory which will reveal to the experienced power plant engineer the general overall efficiency of the plant as a whole and at the same time locate particular places where serious loss and waste occur.

At the Annual Pure Bred Live Stock Show in Chicago and elsewhere in various states, one may see in the ring where the pure bred stock are shown one or more judges who are experts on the particular kind of stock in the exhibit. These judges use a score card containing ten or more items or points, each point relating to a standard of perfection for some particular part of the animal, and the summing up of these points determines the class to which the animal belongs. If the animal scores high in every point, the sum total of points decrees that animal to be nearly perfect.

I have found it practical and instructive to make use of a similar method in judging of hotel power plants. In employing this scheme, I have found it of advantage to note the condition of the plant in respect to the following ten items:

1. Water.
2. General Design and Arrangement.
3. Class of Equipment.
4. How Long in Service.
5. System of Maintenance.
6. Efficiency of Each Machine.
7. The Aroma of the Power Plant.
8. A Comprehensive Color Scheme.
9. The Harmonics of the Power Plant.
10. The Value of Recording Instruments.

Let ten represent the highest score in each division; a score of one hundred then would mean that every division of that plant is of the highest class possible in design, arrangement and operation. The manager and chief engineer might find it both interesting and profitable to ascertain how near their own plant comes to the one hundred score. To do this properly, the chief engineer should not only make a critical inspection of every machine in his own plant, but he should also compare it with newer machines for similar work now on the market which have passed the experimental stage. It will take thinking and planning to do this, but as the work goes on it will be most interesting and profitable.

Wyoming Power Plant Revitalized

The Intermountain Railway, Light & Power Co., of Laramie, Wyo., has been reorganized and refinanced. Rush Holland, of Colorado Springs, has been elected president; E. J. Condon, Sr., general manager; E. J. Condon, Jr., of Colorado Springs, assistant general manager; Ralph Y. Pool, of Colorado Springs, general superintendent of plants.

The company will expend within the next few months $100,000 for needed improvements. R. R. Beddow, local superintendent, says that a new contract has been made with the city for a general enlargement of the street lighting and when this is effected, Laramie will be the best lighted city of its size in the United States.

J. B. Dillon.

Two of the most far-reaching bills on the subject of coal regulation have been referred to the Senate Commerce Committee, the first being a seasonal coal rate bill authorizing the Interstate Commerce Commission to initiate, establish or adjust rates for the transportation of coal during specified seasons which shall be greater or less than the rates for other seasons. The other is a fact-finding bill enabling the Federal Government to keep in close touch with conditions in the coal industry. Senator Frelinghuysen announces that hearings will be held on these bills and that they will be reported as soon as practicable.

Recommendations for Reducing Fire Hazard

CERTAIN STRUCTURAL DESIGNS FOR SPRINKLER SYSTEMS, SHAVING VAULTS, AND SMOKE STACKS ARE RECOMMENDED BY THE GREAT AMERICAN INSURANCE CO.

IT IS GENERALLY accepted in these days that a building of any sort should be properly protected against fire by a sprinkler system. There are, of course, many methods of installing such a system. One, illustrated in Fig. 1, is approved by the Great American Insurance Co. At certain intervals along the length and breadth of the ceiling of each room are fusible plug sprinklers, each of which is connected by a branch line with one or more main headers on each floor. These

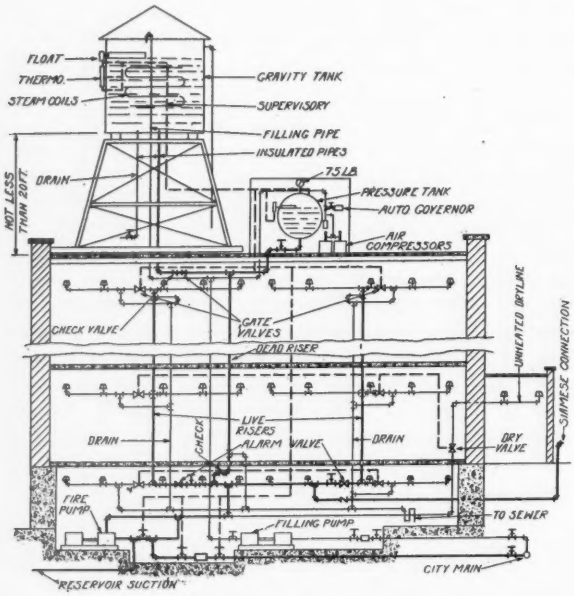


FIG. 1. AUTOMATIC SPRINKLER SYSTEM

headers are in turn connected with a live riser which communicates with a fire pump in the basement of the building, with a Siamese connection on the outside of the building where a fire engine can be connected, and with both a gravity and pressure tank on the roof.

These four systems are connected in parallel so that any one of them may be used. The fire pump takes water from the municipal main or from a reservoir and delivers to a main header in the basement from which the live risers are supplied. Supply to this header is also obtained through a lead to a Siamese connection on the street. Both the gravity and pressure tank on the roof feed to this header through a common dead riser. All leads to this header are provided with check valves.

The gravity tank is supplied by a filling pump in the basement. It is supplied with a steam heating coil having a thermostatic control and with a float valve. The pressure tank is supplied by the same pump. It is under air pressure maintained by an air compressor on the roof.

A supervisory system gives an alarm when the water level in either roof tank falls, when the temperature of the gravity tank approaches zero, when the pressure in the pressure tank falls or when any of the control valves on the system are operated.

SHAVING VAULTS AND BLOWERS

IT IS generally considered that any woodworking plant or factory presents an unusually large fire hazard owing to the presence of shavings and sawdust all over the property. Such, however, need not necessarily be the case. Figure 2 shows how such a factory should be equipped with a shavings vault and blower system to minimize materially this hazard. The mill is of the standard mill construction with brick walls. The boiler room and the adjacent fuel vault are outside the mill proper, being separated by the wall of the building. Both the vault and the boiler room, which are separated by a 12-in. brick wall, have fireproof concrete arch roof construction.

All dust and shavings are collected directly from each machine in the plant by a blower system as soon as made and in addition a floor sweep is provided to collect any stray waste. A motor driven fan or exhauster conveys this waste to a cyclone separator immediately over the vault where the material is deposited. This chamber is provided with a vent and also a steam jet which is to be used in case of fire. An opening fitted with an iron drop door hung with counter weights is provided through which the fuel may be shoveled into the boiler room. In the lift cord is fitted a fuse link which will melt in the event of fire and allow the door

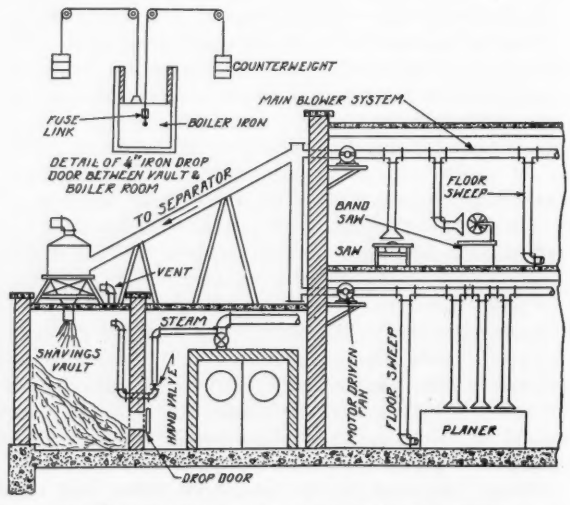


FIG. 2. SHAVING VAULT AND BLOWER SYSTEM

to fall. This construction is shown in the insert of Fig. 2. It will be noticed that none of the pipes of the blower system pierce the floors. The connection between the systems on each floor is made outside the building.

STEEL STACKS

LITTLE consideration is too often shown in the construction of steel stacks. Frequently such stacks are led through a roof of mill construction with but scant clearance between them and the wooden roofing. When it is considered that the temperature of the flue gases passing through a stack is usually around 600 deg. F. and in

cases of overload or short circuit through the furnace may exceed 1000 deg. F., there is small wonder that fires occur as often as they do. Records show that a large percentage of fires involving material damage to property have been started in this way. Figure 3 shows the approved construction. There should be an annular opening at least 18 in. wide between the stack and the woodwork and in addition there should be a metal casing fitted to the opening in the roof. This casing should extend below the roof joists and should be lapped over to protect the bottom edge; it should also extend above the roof level a distance of 9 in. A conical skirt or hood

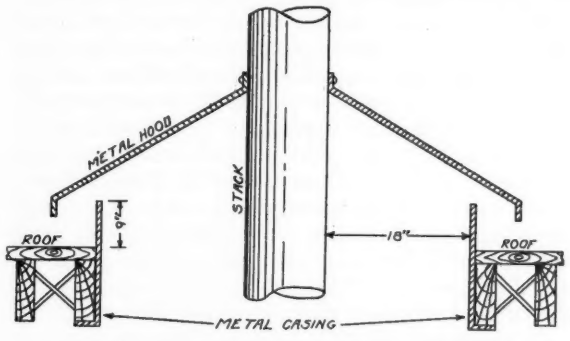


FIG. 3. APPROVED SMOKE STACK CONSTRUCTION

should be hung from the stack to cover the opening as a protection against the weather.

There should of course be no connection between this hood and the casing for the reason that such construction would not allow the necessary circulation of air around the stack and would, furthermore, permit direct conduction of heat to the casing.

Freezing Time for Can Ice

A DIAGRAM for determining the freezing time required for can ice of various thicknesses for various brine temperatures is a convenient bit of information to have about an ice plant, when, because of changes in the consumers' demand, it is necessary to regulate the rate of manufacture.

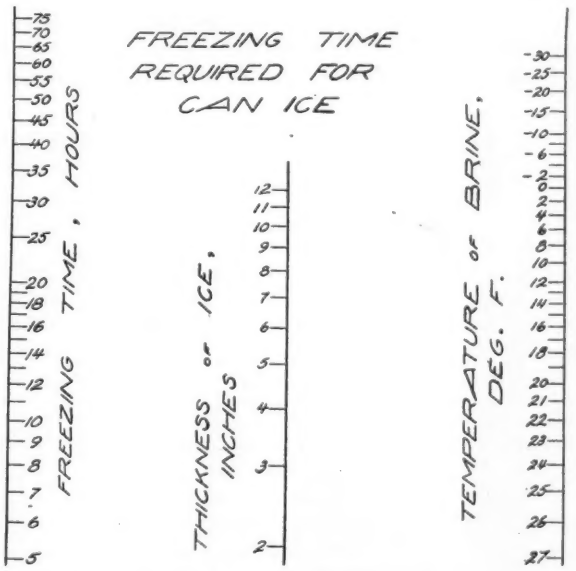
Such a diagram is here shown.

If, for instance, the demand for ice increases, it becomes necessary that more ice be made in a given time. As the number of cans in service is a fixed quantity, the rate of freezing must be increased, or the time required to freeze a can must be cut down. In order to accomplish this result, the temperature of the brine must be reduced by evaporating more ammonia.

The question is how much should this temperature be reduced to obtain the desired result? The answer can be found on this alinement diagram.

An expression derived for determining this quantity necessarily contains three variables, the thickness of the ice, the time required for freezing, and the temperature of the cooling medium, brine. An empirical equation expresses the relation existing between these quantities as $H = 7T^2 \div (32 - F)$, where H = freezing time in hours; T = thickness of ice in inches, and F = brine temperature, deg. F.

The diagram is constructed on this equation. The scale on the left represents freezing time. It is simply a logarithmic scale starting at 10 on a given datum line. The right-hand scale reads deg. F., but was plotted for values of $(32 - F)$ and then numbered in terms of F. $(32 - F) = 10$ is located on the datum line. The divisions correspond to the same size logarithmic scale as used on the left. The center scale, equidistant from the other two, was originally a half size scale starting with 1 on the datum line. The point 7 on this scale was taken as the starting point for a new full size scale at the 10 position. Thus a point on this scale representing the thickness of the ice is really representative of the quantity $7T^2$.



ALINEMENT DIAGRAM FOR DETERMINING FREEZING TIME REQUIRED FOR CAN ICE WITH VARIOUS BRINE TEMPERATURES

A straight line passed through any two known points on any two scales will intersect the third scale to give the value of the third variable. For instance, if we have ice cans 11½ in. thick and use brine at a temperature of 14 deg. F., a straight line passing through these points will intersect the time scale at 15.4 hr., or if it is required to freeze 10 in. ice in 40 hr., we find by the same method that it will be necessary to use brine at a temperature of 14.5 deg. F.

Purging Air Out of Ammonia Systems

By N. G. Near

REFRIGERATION authorities tell us to "place the purge valve at the highest point on the condenser."

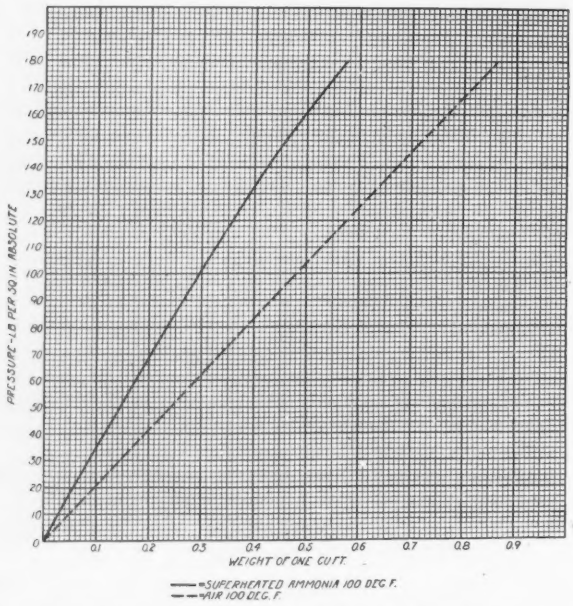
The writer has had some trouble with air in ammonia systems and is not convinced yet that the purge valve should be placed at the highest point. Herewith is a chart showing two curves—one an ammonia curve and the other an air curve, both at 100 deg. F. The temperature 100 deg. F. was chosen because that is perhaps the average temperature of the condenser while in operation, hence both the ammonia and air would have that temperature.

This curve was plotted because the writer was told

in an argument on the subject—"Yes, at low pressures, ammonia *is* lighter than air, but at a certain pressure the curves cross and air is lighter than ammonia." These curves, however, plotted from data given in Marks' Handbook, show definitely that at ordinary working pressures ammonia is about 62 per cent as heavy as air. Air is always heavier. The air line is straight, whereas the ammonia line curves towards the air line, but the curvature as will be noted is very slight.

Theoretically, therefore, on the basis of these curves, the purge valve should be placed at the "lowest" point in the condenser; in fact, the air should be purged out of the receiver, just above the liquor line.

On the other hand, it is quite possible that it makes no difference where the purge valve is placed, provided it does not permit liquid ammonia to escape. My reason



VARIATIONS IN WEIGHT OF AIR AND AMMONIA GAS

for saying this is the not-so-well-known property of all gases eventually to mix.

It is well known by all refrigerating engineers that when ammonia escapes it goes upward. We are instructed, in case of a serious leak, to "breathe close to the floor," which is correct; but, eventually, the ammonia will be just as dense at the floor as at the ceiling. All gases mix, and after they are mixed they cannot be separated centrifugally as is possible with liquids of different specific gravity. Hence it is quite possible that in ammonia condensers, where air may have existed for several days, the mixture is complete and it therefore does not matter much where the purge valve is placed. To purge thoroughly, though, while the plant is in operation, it is the writer's opinion that the best point is just above the liquor line. During the condensation process, the newly formed ammonia gas then pushes the air and ammonia mixture downward and the familiar "crackling sound" occurs sooner than when purged from the highest point. When purging from the highest point, newly formed pure ammonia gas will escape if the purging is done during operation.

Ammonia Protection

WORKMEN SHOULD BE PROVIDED WITH ADEQUATE PROTECTION AGAINST AMMONIA FUMES

BECAUSE OF the widespread use of ammonia refrigerating plants, it is vitally necessary that the employes working in these plants be provided with an adequate protection against the ammonia fumes which are likely to be encountered in case of an emergency.

In the pure form, ammonia is a colorless gas and has a sharp, penetrating odor. Under high pressure it can be condensed to a liquid. When the pressure on a tank of liquid ammonia is released the liquid evaporates into a gas again. Much heat is absorbed in the process of evaporation and the cooling effect is utilized in refrigerating and artificial ice plants. The temperature of liquid ammonia when exposed to the air is 37 deg. F. below zero, so if any part of the human body comes in contact with the liquid it may be frozen. Should a leak occur in the ammonia-piping system of a refrigerating plant, the ammonia, being under pressure, would escape and fill the room with gas. As the gas is very soluble in water, it may be partially removed from the air of a room not easily ventilated by spraying the air thoroughly with water. In ammonia gas, a handkerchief or cloth wet with water and used as a respirator over the mouth and nose of the workman, if he is caught without other protection, serves to remove much of the gas from the air breathed. The spraying of water from a hose over the neighborhood of the leak also absorbs much of the gas and gives protection.

Ammonia is not considered very poisonous, as it does not often produce death when inhaled. It is, however, quite irritating to the eyes, throat, and lungs in concentrations less than 1 part of ammonia to 1000 parts of air. According to Lehman, 0.03 per cent ammonia in air can be inhaled from one-half to one hour without producing serious disturbances. Under the same conditions, 0.3 to 0.5 per cent is considered dangerous. The inhalation of larger percentages may cause a spasmodic closing of the glottis and asphyxiation of the victim.

Experiments at the American Univerisity experiment station show that the average man will detect the odor of ammonia when only 0.005 per cent is present in air; the eyes are irritated when the percentage is over 0.07 per cent and throat irritation begins at 0.04 per cent; coughing is produced by 0.17 per cent. These percentages differ for different persons, as individual sensitivity is not the same.

The standard Army gas mask as issued for military purposes does not provide sufficient protection from ammonia for industrial use or for fire departments. Special ammonia canisters, however, that give complete protection to the eyes and the lungs can now be purchased from commercial supply houses. In fact, a fireman wearing an approved ammonia mask need have no hesitancy in entering any atmosphere containing ammonia fumes which is bearable as regards skin irritation. Two per cent ammonia is about the maximum strength that a man's skin will endure; more than this has an intolerably irritating action on the tender parts of the body, which increases with the concentration. Perspiration accentuates the effect. Exposure of the skin sufficiently long will cause blistering.

Treatment for Ammonia Poisoning

For alleviating the effects of ammonia on the skin, use lint or linen or washed muslin wet with picric acid or the picric gauze supplied with first-aid outfits.

To treat the eyes, first pour a saturated solution of boric acid into the eyes, or use the solution with an eye cup. Have the patient open and close the eyes rapidly to bring the solution in contact with the entire inner surface.

When ammonia gas has been inhaled, dip a handkerchief or gauze, folded once, into vinegar, wring out lightly, and lay loosely over the mouth and nose. If liquid ammonia has entered the nostrils, sniff up some diluted vinegar and apply sweet oil to the inner surface of the nostrils. If ammonia has been swallowed, have the patient suck lemons, or give diluted vinegar, and follow with four teaspoons of sweet oil, milk, or the whites of three or four eggs and ice. If vomiting occurs, aid it with liberal drafts of lukewarm water.—Abstract, Technical Paper 248, Bureau of Mines.

Why Cover the Pipes?

By H. A. Jahnke

SOME manufacturing plant owners or their managers do not see any gain in covering the steam pipes throughout the plant, but keep right on wasting good money in letting the heat from the bare pipes radiate into the air, while the fireman in the boiler room is trying his hardest to keep up the steam pressure in the boilers, especially during very cold weather, and while in some departments of the plant or office the employes are freezing, due to lack of sufficient heat. This not only cuts down efficiency, but the men are sickly most of the time, where, perhaps, a few dollars spent in covering the steam pipe leading to the radiators or heating coils would eliminate this trouble.

To show how true this is, I relate the following. In a new office building, steam radiators were installed of the proper capacity to heat the rooms to the desired temperature regardless of the temperature outdoors during the cold season. But when very cold weather set in it was found that the radiation in the building did not give the expected results, as most of the rooms were too cold to be comfortable for the office employes to work, hence they fell back in their work.

It was about decided to install more and larger radiators in the rooms that did not receive sufficient heat. My attention having been called to the matter, I first examined the entire heating system and found that none of the pipes furnishing steam to the radiators were covered. Then I suggested covering all the live steam pipes leading from the boiler room to the radiators in the office before making any changes in the system. After these pipes were covered with 1-in. thick air cell covering there was no further complaining of insufficient heat in any of the rooms.

In another instance which was in a plant where the general office was located some distance from the factory, the office was heated with exhaust steam from the engine and other steam-using apparatus during the day when the plant was in operation, while during the night live steam at a reduced pressure is used. The steam pipe furnishing steam to the office runs through the factory yard, and was almost 500 to 600 ft. long and 3-in. pipe. This pipe was not covered either in or outside of the building. Any man with experience can imagine what a loss there occurred in the heat radiating into the air in and outside of the building by these bare pipes. This loss was not as great during the daytime when exhaust steam was used as during the night when live steam was used. The office employes used to complain frequently of being cold during very cold weather with all the radiators turned on.

The plant owner had about decided to install more radiation in the office when one of the employes suggested that no more radiation was necessary to get the desired results, but the pipes furnishing steam to the office should be covered. This advice was taken and all pipe in and outside of the plant was covered. After this there was sufficient heat.

In both the foregoing instances, the management had about decided that in order to obtain sufficient heat for the rooms more radiation was necessary, but never gave it a thought to find whether the condition could not be improved in some other way besides installing more radiation. Of course, had more radiation been installed it would have remedied the trouble; but the loss in the heat radiating into the air from the bare pipe furnishing steam to the office would have continued at a dead loss to the concerns while, in covering the pipes, this loss was eliminated for good, besides getting sufficient heat now.

A Suggestion

Where a heating system does not give satisfactory results, do not always blame the radiation in the rooms, as there may be other causes; for instance, the feeder pipes may be too small or the pressure too low to furnish sufficient steam when all the radiators or heating coils are turned on, or the return pipes may be too small to take care of all the condensation, hence some of this remains in the radiators or coils longer than it should when only some of the sections are hot while others are only warm. Air in the radiators or coils will cause the same trouble.

The Suction Oil Burner

By J. M. Row

IN the steam atomizing oil business, we are all familiar with such terms as "inside mixture," and "outside mixture," also with pressure burners and gravity burners, but now comes the "suction burner."

While testing various types of burners in view of selecting one best suited for an installation under my supervision, I received my first introduction to the suction burner. This burner was guaranteed to lift, heat and atomize the oil. The oil, being always under vacuum, made unnecessary the use of an oil pump, as well as all the mess and filth incident thereto. The oil was heated and atomized as well as being lifted, the whole performance requiring about 3 per cent of the steam generated.

The construction of the burner is similar to that of a single tube injector, and derives its lifting ability from the same source as that of the injector. The oil is drawn into the suction chamber, the end of the steam nozzle, and from there, in contact with the steam, is blown through the atomizing nozzle, and into the furnace. This is necessarily an inside mixture burner, and gives a long, clear, fantail flame.

Pipe Fitting Troubles

FIGURE 1 illustrates a case of injector trouble that tied up a 90-ton wrecking crane. The crane was out on a job when the injector began bucking, finally refusing to handle water at all, and the engineer was forced to pull the fire. The crane was hauled to the round house and three different injectors tried, all with the same results, so the master mechanic had the gang of pipe fitters take down all the pipe. Everything was clear, so it was put up again and the same results obtained. The crane was put in the shop on Saturday noon and

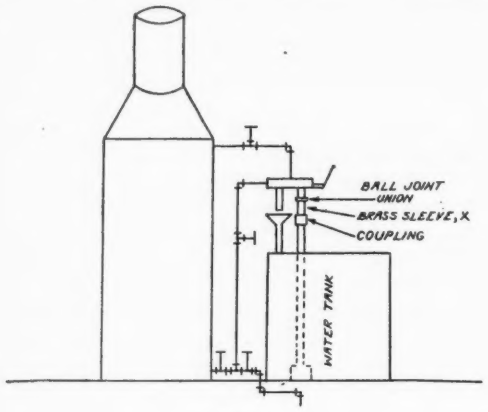


FIG. 1

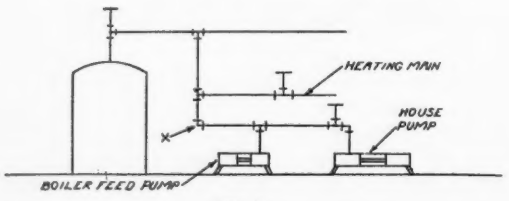


FIG. 2

FIG. 1. LOCATION OF CRACKED UNION IN INJECTOR PIPING
FIG. 2. PUMP PIPING WHICH FILLED WITH SCALE

worked on till Sunday evening when the night roundhouse foreman, who had been off Saturday night, was called. He finally located the trouble at X in the sleeve of ball joint union on suction line, which was cracked. Not having one of the same size and rush orders coming in for a crane, an old sleeve of a larger size was taken off an old syphon and ground down; time for crane out of commission, 36 hr.; 2 pipe fitters, 30 hr.; master mechanic, 20 hr., and night roundhouse foreman, 8 hr.

Figure 2 illustrates the arrangement of piping in another plant which had operated for years without any trouble. It suddenly took a streak that, when the house pump was started, the boiler feed pump would refuse to put water into the boiler, neither would the house pump raise the necessary pressure. On taking down the pipe, the elbow at X was found to be nearly filled with scale and rust. Removing this cured the trouble.

In another case both injectors and lubricator on a locomotive, working in an open pit mine, refused to work. The engineer tried the valve next to boiler, but could not seem to get it open any wider, and as water was getting pretty low, ran to the roundhouse and dumped fire. After investigation it was found that the valve, which was supposed to be open, had left-hand thread on stem, and the vibration caused by rough track had worked it nearly shut, and in the strenuous moments of getting it open the engineer had finished closing it. So much for not watching the little things.

At one time we used a boiler compound, in the plant of which I have charge, and it did not satisfy me. The amount prescribed by the manufacturer was used, with no result. If enough was used to remove any of the old scale, foaming would result, and the heating system, which is of the vacuum type, is operated about 12 hr. daily on live steam reduced to 3 lb., began to act mysteriously. Some coils would stop heating and get cold, and upon investigation the vacuum traps, which are of the expansion type, would be found full of a substance that looked like a yellow clay of the Missouri mud variety. Lastly, the engine began acting up. All at once, it sounded as if a sledge hammer gang was in the crank case trying to wreck the crosshead. More oil was supplied and also pumped in by hand, but the relief was only temporary. Next, the indicator was applied and to all appearances the valve setting was O. K., so, as a last resort, the remainder of that particular compound was dumped on the ash pile, boilers cleaned and a boiler metal treatment applied, since which time no trouble has been experience.

I have read in several issues inquiries about intermittent engine knocks. I believe that if the proper course of investigation were carried on the trouble would be located in either too much water getting into the engine, and I can state from experience that a receiver-separator of large capacity is not always an insurance against water getting over into the cylinder, or else an aggravation of the water proposition by the use of a compound containing some form of a caustic soda or too much soda ash.

OPERATOR.

Don't Lengthen Your Wrenches

IN COMMENTING on W. F. Schaphorst's letter on page 392, April 1 issue, I wish to say that Mr. Schaphorst's logic is all right from a theoretical standpoint, or will apply as far as wrenches to be used on small bolts or studs are concerned, that is from ¾ in. down, but for

sizes larger than this, in certain classes of work, such as the tightening of cylinder heads on Diesel, or semi-Diesel engines, it will not hold good.

I do not advocate the lengthening of wrenches for any class of work except in the very large sizes, that is, from 1½ in. up; but I do advocate the use of a soft hammer on sizes from ¾ to 1½ in.; in fact, this is the only practical way to tighten nuts with any degree of accuracy, as a wrench and hammer in the hands of an experienced man is a desirable and effective way of drawing down cylinder heads, and by drawing each nut a little at a time, the tension on the bolt, or stud, is much more easily determined than if the wrench had been lengthened.

We have a 100-hp. semi-Diesel engine in the plant of which I have charge, and I will say that no man could take the standard 1-in. wrench (1 in. being the size stud) using no other leverage, and tighten the heads so that they would not allow the cooling water to leak between the cylinder and the head.

The danger in the practice of using a hammer on a wrench is that the ordinary man around a plant thinks that every time he picks up a wrench he must also pick up a hammer to be used on it, if it is of a size except for the smaller bolts; this is a sad mistake, for on a piece of work where it is necessary to use a hammer, it should not be done by anyone except an experienced man, and the man in charge should not permit anyone else to do it.

The tightening of cylinder heads is a very particular piece of work, and must be executed with great care, each nut drawn down a little at a time until it is thought that each one is just tight enough, and each having as near an even tension as possible.

F. C. DeWeese.

In the April 1 issue is a short sketch by W. F. Schaphorst entitled "Don't Lengthen Your Wrenches," which, in my opinion, is good advice and should be heeded by all.

Some years ago, I had charge of a large plant where I had two steam fitters and their helpers, two plumbers and their helpers, ten firemen and four engineers. I happened to run out of pipe wrenches, and I could not buy any with wood handles, that is 18, 14, 10 and 8-in., those sizes I generally bought with wood handles, so I bought six of each size with steel handles and when the men wanted wrenches and brought the old wrenches to exchange, I gave them those with steel handles. In a little while one of the men came back and said that the wrench was no good, it hurt a fellow's hand when you pull on it hard. I told him when he pulled hard enough to hurt his hand it was time to get a bigger wrench.

I never bought another wood handle wrench and the bill for small wrenches was never so large after that and I would not let them lengthen the handle with a piece of pipe. H. Armstrong.

Pump Versus Trap Feed

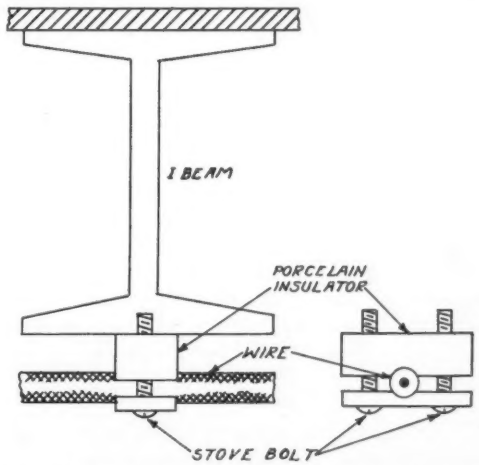
In April 15 issue, page 434, W. H. Wakeman stated his opinion in regard to the above subject, in answer to W. L. N.'s letter of March 1 issue. Mr. Wakeman states that he does not see where the return trap would be of any advantage for feeding water to the boiler over a steam driven boiler feed pump. I had this same opinion for many years, but of late have been convinced that there is considerable saving made with the return trap. How much saving is made in each installation cannot be figured accurately.

We all know that to get the most efficient results from the boiler it is important that it has a good water circulation. Now, if cold water is pumped into the boiler this retards the circulation as the water requires so much more heat before it is generated into steam than water around 210 deg. and above. The reason that the return trap shows more economy than the boiler feed pump is because it discharges the water into the boiler at a higher temperature, therefore increasing the circulation and making the boiler more efficient.

L. Kjerulff.

Supporting Conductors on I-Beams

In the May 1 issue, page 469, Mr. Barth describes a method of supporting open work conductors on I-beams. I have had considerable experience with this kind of work and it seems to me that the method described entails a bit more work and material than necessary.



SIMPLE METHOD OF SUPPORTING OPEN WORK CONDUCTORS ON I-BEAMS

It is almost certain that any plant containing as much I beam as is indicated on Mr. Barth's drawing will have a portable electric drill lying around somewhere. With the aid of such a drill, a few taps and some stove bolts, the job of installing open work conductors is greatly simplified, as the accompanying sketch will show. The sketch is self-evident and needs no explanation.

A better way, however, would be to use conduit and mount with ordinary pipe straps.

John F. Weim.

Concerning Coal

From all sides, we read of coal mines being idle.

Recently I talked to some officials of the large coal companies of Colorado, and they freely stated that there were plenty of cars and plenty of coal, but there was no

demand. If the reports we see in the newspapers are correct, these same conditions seem to be general.

What's the matter, folks? Would it not be a good idea to grab a big pile of coal at such times? Not only will you get it cheaper, but you will incidentally be carrying out that slogan we see in many byways: "Buy what you want and give the other fellow a job."

J. B. DILLON.

Superfluous Valve; Cutting in Boilers

ON PAGE 481, May 1 issue, W. H. Wakeman gives the impression that he does not think there is any advantage in having a valve on the outport pipe. In the winter, when steam is kept on the building at night, there are times when the watchman is on his rounds, and the steam pressure drops low on the boiler; some reducing valves will at times start opening more, and if you were carrying 2½ lb. on the heating system with a weighted back pressure valve that was set for 3 lb. relief, the pressure will build up to above 3 lb.; this, of course, will allow the steam to escape to the atmosphere, and before the watchman gets around he has lost most of his steam. If he had a valve to shut, as Mr. Jahnke shows in Fig. 3, April 1 issue, he would not lose his steam that way.

About cutting a boiler, I believe that a wrong impression is being given to young students. Mr. Wakeman states that boilers have been cut in at a difference of 50 lb. and all went well; but I believe that it is dangerous to cut in with a difference of over 10 lb., and the greater the difference in pressure the more danger. Turning steam into an engine cylinder or tank, to my mind, is not to be compared with the boiler at all. The boilers are partly full of water, just full of power ready to be liberated, while steam cylinders or tanks have no water except the condensate. Engineers know what effect it gives to turn steam into cold water as in a bleach tub or kier. This, of course, is an exaggeration because there is a greater difference of temperature than that of two boilers, but the same principle is involved.

W. L. N.

W. H. WAKEMAN gives opinions concerning "Can Boilers of Unequal Pressure Be Connected?"

Yes, they could be connected through the medium of the bypass (or communication valve) on the lower pressure boiler. Great care must be taken; for, if the valve on the higher pressure boiler were opened suddenly, the water would be almost liable to prime, from high pressure into low pressure boiler, or at least excessive water hammer may take place in the steam pipe.

Except in cases of extreme urgency, it would be far better to have an equal, or nearly equal, pressure on both boilers before connecting them up.

Then, again, we must also take into consideration that we have more wear and tear on our valves when cutting in boilers of too great a difference in pressure.

In our plant we have a battery of three 500-hp. water-tube boilers, each boiler equipped with an automatic nonreturn-steam trap valve, of a good make, and although we do not take any chances, still we are perfectly safe in opening all our valves, from boiler under pressure into the dead one and still not have one pound pressure in dead boiler; then we could start fire going under dead boiler and when the steam pressure equals the pressure of the boiler in service, the valve will automatically open.

Also, Mr. Wakeman should not forget that in cutting in boilers of 50 lb. difference in pressure, if he has a return tubular boiler, he is liable to have his water held in suspension, for the time being, which could cause his crown sheet to come down, notwithstanding the fact that in the event of his having an engine running, he stands a chance of having the cylinder head knocked out.

RAYMOND J. ROE.

ON PAGE 481, May 1 issue, W. H. Wakeman wishes to know why it is dangerous to cut in a boiler when the pressure is different from that in the main line. In case of a horizontal pipe leading from the outlet riser on the boiler to the main steam line, especially with an angle valve on the riser, if the horizontal pipe should pitch toward the boiler (which sometimes happens, due to the boiler setting having settled) there would be water in the horizontal pipe. On opening the angle valve with the pressure lower in the boiler than on the line, a water-hammer would result, causing a possible rupture of the body of the angle valve. It would be comparatively safe under these conditions if the boiler pressure were slightly higher than that in the main line.

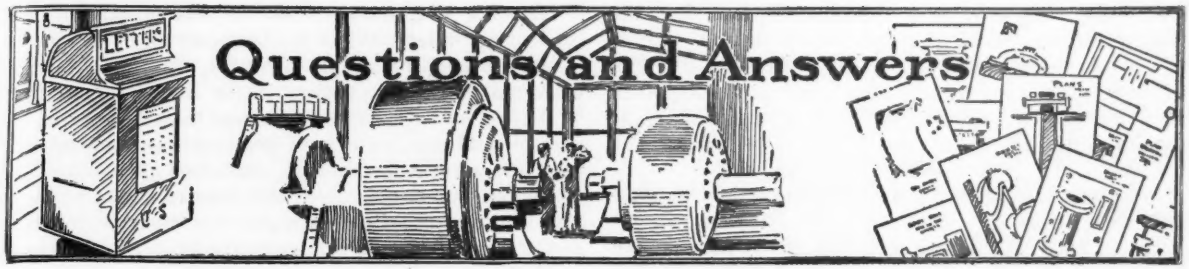
If the valves were so located that steam could be let into a cold boiler without water-hammer, the upper part of the boiler occupied by the steam would expand so much faster than the lower part that undue strain would affect parts, which might in time cause a rupture.

On a recent visit to a Massachusetts plant my attention was called to a crack in the bottom of a digester, which was caused by turning live steam into the top at about 15 lb. pressure, the top expanding before the bottom warmed up, pulling the metal apart. The crack was repaired, and openings for a ¼-in. pipe tapped out in several places in the bottom to admit steam for warming the shell slowly before turning on the pressure. There has been no trouble since.

In cutting in a boiler having a higher pressure than the main line, a sudden opening of the valve will cause the water to lift in the boiler, sometimes with violence.

The human element should be considered in this matter; a careful man will often get by in cutting in a boiler under different pressures by carefully opening the valve, whereas another man would proceed to open the valve right off as though there were no difference in pressure on either side, which would probably get by if the pressures happened to be equal. The policy of having the pressure equal at all times when cutting in a boiler is the safest course. I. F. RICHMOND.

THAT the largest supply of gasoline on record in the United States was on hand April 30, 1921, is disclosed in a preliminary statement of stocks of gasoline at the refineries on that date just issued by the Bureau of Mines. The report shows a total stock of 755,000,000 gal. of gasoline, a net increase of 42,000,000 gal. over the figures for March. The largest increase, amounting to 18,000,000 gal., occured in the Texas and Louisiana division. In the Pennsylvania division, a decrease of 4,000,000 gal. was shown. The Bureau of Mines plans to continue the compilation of similar reports for the next 3 mo.



Boiler Inspection

WHAT ATTENTION should be given a boiler before putting it up for the summer? What inspections should be made and what provisions to prevent its rusting?

H. C. M.

Conveying Water

WILL YOU kindly advise me as to the most satisfactory and economical method for conveying 25,000 gal. of water per day a distance of 1700 ft. with a rise of 20 ft.? The water is taken from a creek below our plant. What size pipe should be used? V. H.

Chimney Construction

WE INTEND putting up a brick stack 100 ft. high and 6½ ft. in diameter at the top. The section is to be square from the foundation, on a level with the boiler room floor, to the roof, a distance of about 25 ft., then continuing round. How many bricks would be needed? How many fire bricks would be needed for the lining? What size should the chimney be at the base? Is a 12 by 12 by 4-ft. foundation of ample size? R. R. J.

Reducing Grate Area

WITH REGARD to the interesting story on page 489, May 1 issue, Reducing Grate Area, I would like to add something.

Like Mr. Misostow, I, too, have had a little experience with reducing grate surface in a steam boiler, in order to handle the loads below the rating of the boiler in question more economically. When a boiler is properly loaded, it has been designed so that the required quantity of fuel may be consumed at the most economical rate of combustion. If, on the other hand, the boiler is overloaded, then, with the same grate area more fuel must be consumed in a given time to meet the overload conditions; this, further, means a more rapid rate of combustion, possibly necessitating the installation of forced or induced draft apparatus. Under these conditions, and of course within reasonable limits, the efficiency of the boiler will be increased.

If, on the other hand, the boiler is underloaded, then, less steam will be required, and a lesser quantity of fuel also will be required and with the same grate area as originally designed, the rate of combustion must be reduced. This means less "draft," or a sluggish burning fire. With a slow burning fire, there must be considerable loss, as is well known, and the way to overcome the greater part of that loss is to reduce the grate surface as related in the article to which I have referred.

I say that only part of the loss due to slow combustion may be prevented; for when reducing the grate surface, the boiler cannot be quite so efficient as it is at the load for which it was designed, nor even as efficient as when an overload is carried. It is better, however, to reduce the grate area for an underloaded condition, than not to do it at all, and so make some saving at least.

Several years ago I had occasion to look into the matter of an underloaded boiler in a small plant, and solved the problem by reducing the grate surface with considerable success. In this case, part of the day—the greater part—the boiler was underloaded, while for a short period in the morning, and again at night, the load was normal. In brief, the load changed from normal to less than one-half load. We could not cut down the grate surface to such an extent as to suit the underload conditions, for then we would have been put to trouble for the full load periods, so we compromised by cutting down as much as we dared, and installed a blower to help out during the full-load periods. Thus a saving was effected that was unmistakable, as was proved over a period of several years. Correspondent H. F. W. will make no mistake in reducing grate surface, if he uses judgment in so doing, and completely analyze the problem. CHARLES J. MASON.

Boiler Seams; Leaky Piston; Valve Installation

ON PAGE 485 of May 1 issue are three questions:

1. Can a butt seam be used on the furnace plates of an internally fired boiler?

2. How may a test be made for a leak past the piston or inside packed plunger of a water pump?

3. In placing a globe valve on a feed-water line to a boiler should the pump deliver water under or on top of the disc?

ANSWERS

YES, you can use a butt joint if you desire to, but this should be made a single strap butt joint. Lap joints are generally used; there is not much strain on them, as the shell of the firebox is under a collapsing pressure which is resisted by staybolts that pass through the firebox sheet, through the water leg and through the outer shell.

2. I have always considered that the best way was to take off the cylinder head, block the piston in center of stroke (this can be done by blocking at the spool or crosshead arm), take out the discharge valve in valve deck back of piston, open discharge valve, start up injector or city feed and you will have pressure back of piston, which will force the water by the piston if it leaks.

3. The Massachusetts State law on page 24 says

that when a globe valve is used on the feed line, the water must come under the disc. The reason for this is, in case the disc should come off, you could still get water in the boiler; while, if the water came the other way, it would hold the disc to the valve seat, and would mean a shut-down. W. L. N.

I SUBMIT the following answers to questions on page 485, May 1 issue:

1. A butt constructed seam cannot be used on the furnace plates of an internally fired boiler for the reason that in this construction the metal at that point would be so thick (three thicknesses of plate) that the water in the boiler could not cool it fast enough, or, in other words, absorb the heat from the furnace through it fast enough to keep it from burning.

2. A test for a leak past the piston of an inside packed water pump may be performed by taking off the head plate from the end of the cylinder, and then starting the pump, it will then pump water on one end of the pump only. Any leak can easily be seen during the pressure stroke of the pump.

3. In placing a globe valve on a feed water line the pump should deliver under the disc. If the pump should deliver on top of the disc, there is a liability of the disc becoming loose from the stem, the pressure from the pump forcing the disc onto its seat, which would prevent any water getting into the boiler.

I. F. RICHMOND.

Ammonia Accumulator

I HAVE, under my care, the expansion side of a refrigeration installation amounting to about 450 tons. In this installation there is an accumulator through which the liquid passes before reaching the expansion valve, which causes considerable superheat of the returning ammonia gas; but although I am aware of this, I would like to know how to overcome it. A good discussion of the superheated ammonia tables and their use would be appreciated. I might say that under normal conditions I carry 44 lb. back pressure and 185 lb. head pressure. This is for refrigeration use to cool 1000 gal. of water per min. from 50 to 40 deg. F.

S. B. T.

A. The accumulator, as used in the ammonia system of refrigeration, is one of several types of liquid precooling devices.

In the operation of the accumulator, the ammonia returning from the evaporating coils with its load of heat is given an additional load in the form of the heat units contained in the liquid ammonia which is on its way to the evaporating coils.

The liquid ammonia leaving the ammonia condenser has no superheat, as its temperature is lower than the temperature of saturated vapor subjected to the pressure that exists in the condenser.

With 185 lb. condenser pressure, the temperature of the saturated vapor is just about 96 deg. This is the temperature of the ammonia just after the superheat of the discharged gas has been removed by the circulating water. The ammonia begins to take the liquid form when its temperature is lowered below the temperature of the saturated vapor.

Then after the ammonia has become liquefied, its temperature is lowered to a point that should be but a very few deg. higher than the temperature of the condensing water. When the temperature of the water is 50 deg. and the supply plentiful, the liquid can be delivered to the expansion valves at a temperature of 55 deg. or less. This liquid can then be said to be precooled 41 deg., as it is 41 deg. lower in temperature than the saturated vapor at condenser pressure.

Before this liquid can absorb heat from the produce that is to be cooled, its temperature must be lowered to the temperature of the ammonia vapor in the evaporating coils. This temperature will depend on the pressure that is carried on the evaporator, which is the same as that in the accumulator.

The liquid that enters the accumulator gives up its heat to the vapor that is passing to the compressor. In this way every pound of ammonia that enters the evaporating coils is able to take up its full load of heat from the surrounding air or brine.

By the use of the accumulator, it is possible to have every foot of evaporating surface in contact with liquid ammonia or vapor in a heavily saturated state. If the ammonia were not cooled to the evaporating temperature before entering the coils, some of the ammonia in the coils would be given this additional heat which would then be carried the entire length of the coil. This would mean a direct loss in real heat absorbing coil surface.

To get the best results from a system that is connected to an accumulator, the evaporating coils must be operated flooded so that the vapor entering the accumulator is not superheated even one deg. The ammonia vapor must leave the coils at the temperature of saturated vapor at the pressure that is in the coils.

The liquid ammonia that is to enter the coils is fed into the accumulator at a point about midway between the top and bottom. This liquid, being heavier than the vapor, drops down to the bottom of the accumulator and passes to the coils, entering at the bottom.

Any liquid contained in the saturated vapor that is returning from the coils will also pass back into the coils by gravity. In this way the accumulator acts as a separator and prevents slugs of unevaporated ammonia from entering the compressor. The vapor passing to the compressor from the accumulator should be superheated only a few degrees.

When carrying a back pressure of 44 lb., the temperature of the saturated vapor is about 30 deg. If the liquid ammonia is cooled to 55 deg. by the circulating water, but 25 deg. remains for precooling. One pound of liquid at a temperature of 30 deg. is capable of taking up 537 heat units during vaporization, hence it is readily determined what amount of liquid is precooled by a pound of ammonia in the accumulator.

Dividing 537 by 25 gives over 21. This means that 21 lb. of liquid can be cooled to the temperature of the vapor in the evaporator by the heat absorbing power of one pound of 30-deg. ammonia.

A. G. SOLOMON.

Miscellaneous Questions on Electricity

1. WHAT IS a volt?

A. A volt may be defined as the electromotive force required to cause the flow of 1 amp. of current through a resistance of 1 ohm.

2. What is an ampere?

A. An ampere is the practical equivalent of the unvarying current which, when passed through a solution of nitrate of silver in water in accordance with standard specifications, deposits silver at the rate of 0.001,118 grams per second.

3. What is an ohm?

A. An ohm is represented by the resistance offered to unvarying electric current by a column of mercury at 32 deg. F., 14.4521 grams in mass, of a constant cross sectional area, and of a length of 106.3 centimeters.

4. How many circuits are allowed in any one conduit?

A. Not more than 12 wires shall be installed in a single conduit without special permission. The same conduit must not contain circuits of different systems.

5. How should electrical conductors be installed when run in elevator shafts?

A. In conduit only.

6. What is the smallest size conduit which can be used?

A. One-half-inch conduit is the smallest size available.

7. When may a junction box be concealed?

A. The National Electrical Code specifies that "junction boxes must always be installed in such a manner as to be accessible."

8. What is the necessary procedure for making a permanent and effective ground?

9. How should a ground wire be installed?

A. Ground connections to metallic piping systems should be made by means of an approved clamp which is bolted around the pipe after all rust and scale has been removed, or by means of a brass plug tightly screwed into the pipe or fitting, or by other equivalent means.

The ground wire should be attached to the clamp or to the plug by means of solder or by an approved solderless connection.

The point of connection should preferably be in plain sight and as readily accessible as possible.

Artificial grounds should be located, where practicable, below permanent moisture level. Each ground should present not less than 4 sq. ft. surface to exterior soil. Areas where ground water level is close to the surface should be used where available.

Where ground plates are used they should be at least No. 16 Stubbs gage copper; when driven pipes are used they should be galvanized iron and not smaller than 1 in. internal diameter; and when cast-iron plates are used they should be at least ¼ in. in thickness.

Where, because of dry or other high resistance soils, it is impracticable to obtain artificial ground resistance as low as 25 ohms, two such grounds 6 ft. apart if practicable should be installed.

10. What is the reason for permanently grounding an installation of wire mould, armored cable or conduit?

A. Primarily to prevent personal injury due to shock.

11. How many bends are allowed in one run of conduit?

A. The conduit should have not more than the equivalent of four quarter bends from outlet to outlet.

12. What is the smallest inside radius allowed in bending an ell in conduit?

A. All elbows or bends in a conduit installation should be so made that the conduit will not be injured. The radius of the curve of the inner edge of any elbow should not be less than 3½ in.

13. What are the requirements for connecting up an electric sign?

A. Leads from electric signs must pass through the walls of the signs either through approved metal conduit or armored cable, or must be neatly cabled and pass through one or more approved, non-combustible, non-absorption bushings. Not over 1320 w. shall be dependent upon final cutout.

14. How many amperes are used by a heating device rated at 1980 w. at 120 v.?

A. The amperage is equal to 1980 divided by 120, or 16.5 amp.

Flow of Water in Pipes

How many pipes, 2 in. in diameter, will be required to deliver the same quantity of water that can be delivered through a 10-in. pipe? H. S. W.

A. We will assume that the pressure in each case is the same, otherwise a 10-in. pipe under a certain pressure might deliver less water than will a 2-in. pipe under a greater pressure. As friction is the determining factor here, and as it varies with the length of pipe, we will assume a length. Obviously, if the pipe were exceedingly short, the areas of the two systems, neglecting entrance losses, would have to be the same for equal delivery. In other words, there would have to be twenty-five 2-in. pipes.

Assuming the length of pipe to be 1000 ft. and the head 50 ft., and neglecting entrance losses, the velocity of flow may be computed from the Hazen and Williams's formula.

$$v = 1.318 \times c \times r^{0.63} \times s^{0.54}$$

where v is the velocity in ft. per sec., c is a constant depending on the nature of the surface of the pipe and which may be taken as 120 for ordinary cast-iron pipe, r is the mean hydraulic radius which for pipes running full is equal to ¼ the diameter, s equals head divided by length. Evaluating this equation, we get

$$v = 1.318 \times 1.20 \times (2 \div 12 \div 4)^{0.63} \times (50 \div 1000)^{0.53}$$
$$= 1.318 \times 1.20 \times 0.0417^{0.63} \times 0.05^{0.53}$$
$$= 1.318 \times 1.20 \times 0.1351 \times 0.2044 = 4.367 \text{ ft. per sec.}$$

The quantity of flow is then $v \times A = 4.367 \times 0.7854 (2 \div 12)^2 = 0.0952$ cu. ft. per sec.

Similarly, for a 10-in. pipe, we have

$$v = 1.318 \times 120 \times (10 \div 12 \div 4)^{0.63} \times 0.2044$$
$$= 1.318 \times 120 \times 0.3724 \times 0.2044 = 12.0389 \text{ ft. per sec.}$$

and Q, the quantity discharged $= v \times A = 12.0389 \times 0.7854 (10 \div 12)^2 = 6.561$ cu. ft. per sec.

Thus it will be seen that the larger pipe discharges $6.561 \div 0.0952$ or 68.9 times as much water as the smaller one and hence sixty-nine 2-in. pipes will be required to obtain the same flow as with one 10-in. pipe.

Correction Note

On page 537 of our May 15 issue in an article on receiver pressure, the initial pressure is given as 145 lb. gage, when it should be 145 lb. abs.; R is the cylinder ratio instead of the ratio of expansion, as stated.

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Present-Day Refinements

Present-day progress in the field of power plant engineering is dependent not so much upon radically new improvements, or inventions such as has characterized the progress made during the past 25 yr., but rather upon the continued refinement of existing apparatus and operating procedure. We have reached a point where, instead of obtaining savings of 5 and 10 per cent in efficiency by the adoption of a new device we must be content with increases in efficiency of one or fractions of a per cent brought about by further refinements in apparatus already developed to a high degree of perfection. Future progress in the art is destined to follow along these lines.

In hydroelectric as well as in steam plants does this hold true. The past year has witnessed a number of exceedingly interesting refinements in the design of draft tubes and other devices which will appreciably increase the amount of power obtainable from an existing hydroelectric plant. Along this line, besides the development of the hydraucone regainer used for recovering the energy discharged from the runner of the water turbine, may be mentioned the various forms of fall increasers and backwater suppressors. The object of these devices is to counteract the loss in head due to a rise in tail water level caused by freshets, etc., by admitting into the draft tube jets of water at a relatively high velocity. These high velocity jets, by accelerating the velocity of the combined turbine discharge and jets of water through the draft tube, produce a negative head which is added to the head of the turbine. In the backwater suppressors, the energy of the spillway water otherwise wasted is directed so as to remove the backwater from over the draft tube orifice, sweeping it downstream, thus freeing the draft tube from the pressure of water over it.

Refinements in steam plants are being developed along lines almost too numerous to mention. Every last bit of energy must be conserved. It is only by constantly striving towards this end that we may expect to realize appreciable overall savings. By systematically reducing losses one per cent here and one per cent there, we will be able to reduce our net operating cost.

Take, for instance, the matter of using higher steam pressures. Thermodynamic theory indicates that the efficiency of prime movers should increase with an increase of temperature of the steam. Present-day knowledge of the properties of materials and the possibilities of turbine design, however, seem to limit us to a temperature of about 700 deg. F. We have, apparently, already reached the maximum temperature limit. The use of higher steam pressures is being considered, therefore, without, however, increasing the total temperature.

Suppose we take the efficiency shown for a total temperature of 700 deg. F. at a pressure of 300 lb. to represent best present-day practice; by raising the pressure to 400 lb. and by lowering the amount of superheat enough to retain the same temperature; the efficiency can theoretically be increased three per cent.

These figures indicate what can be done theoretically, but it seems probable that the actual savings that may be realized will be less than theoretically possible.

The foregoing examples are indicative of modern tendencies towards a more economical generation of power.

Neither of them, unless it be the hydraulic development, involves any fundamental changes in the design of existing equipment; but they show how, by a careful analysis of the operation and apparatus at hand, new possibilities may be found.

Opportunity for development in this direction is great. Each part of the plant must be considered separately as well as in its relation to other equipment. In the cooling of generators, for instance, closed systems of ventilation have been developed; but in connection with them, it has been suggested that the turbine condensate may be used as a cooling medium for such systems. This would not only provide a continuous supply of cooling water, but would allow of the recovery of some of the heat losses of the generator.

We have in this article merely touched upon some of the interesting developments which have lately come to light. There are numerous others. Each one contains possibilities for obtaining more efficient operation. The principles involved are sometimes deeply hidden from view and it is only by the continued application of known principles and by unselfish, untiring effort and co-operation that we can hope to unearth them for our use.

Service

Service is an excellent thing to talk about in the abstract. We hear and have heard a great deal about it from all sides. Men and women all over the country have been giving their utmost in service to humanity during the war. The war is over but this is no time for a let-down. Service is quite as essential now as it was during the war. Like the babbling brook, giving service is something that must go on forever. The difficulty is that we hear less of it nowadays; it is not spoken of in the same idealistic and patriotic terms as it was. When we get down to the matter of rendering service in everyday life, that seems to be a grey horse of another color.

Methods and machines that have been tolerated during emergencies because of the fact that we were in such a rush that repairs and replacements could not be made, can no longer be retained. Then, output was the prime requisite; efficiency was secondary. Now, efficiency must count for more if we are to progress. Waste must be reduced. By reducing careless loss and waste in power plants, we provide savings which become new capital and may be applied to reduce debts.

Since the hotel is an institution that deals fundamentally in service as a commodity and as it comes in direct contact with a great number of people, it should serve as an example of what efficiency and service in a power plant should mean. George Talcott Ingersoll has taken this view and in a number of articles beginning with this issue, sets forth a code by means of which the condition of a hotel power plant may readily be judged. These articles are not technical; they are meant to reach the average man. As he says, technical men can read and appreciate both technical and non-technical articles while the non-technical men including, for instance, the hotel manager and many of the power plant men who live with the plant and keep it going, can only appreciate the non-technical article. These are the men to whom we look to effect economies. All they need is to be shown the way—where to look for inefficiency.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

The Man Who Gets Things Done

By Dr. Frank Crane

"THE Lord certainly shows His low opinion of money by the kind of folks He gives it to," said the pale young man at the banquet. "Look at Hiram Perkins over there—ignorant, no manners, no grammar, no anything but money." The pale young man was a Harvard graduate, and inclined to socialism and poetry and the future.

"Well," said his Uncle Tom, who sat next to him, "I'm not so sure the Lord missed it on Perkins. To my mind he comes nearer earning his millions than most of us."

"Why, what can he do?"

"Nothing. That's the idea. He doesn't do. He gets things done."

"What things?" asked the young man.

"Oh, any old thing you want," replied his uncle. "There's Hi Perkins, for instance. He came from a little town out in Illinois. He was a foundling. A poor grocer's wife adopted him. He worked in the store. By the time he was seventeen, he had changed his foster father's store from a trivial affair to the biggest mercantile enterprise in town. When he was twenty-one, he had a chain of stores in the surrounding towns. At thirty, he owned the street railway and the waterworks and the electric plant. At thirty-eight, he owned public utilities in a dozen towns. And it wasn't graft, nor the power of unlimited capital, nor anything like that. It was because, somehow, he got things done when everybody else failed.

"There are plenty of people that can do things if you tell them how. Hi Perkins is one of the kind that do things when nobody can tell them how.

"Loyalty, honesty, perseverance, training, education, and all those things are good. But there's something rarer, something that the Creator gives only to the hundredth man. It is the ability to accomplish the impossible. It is the genius for finding a way. And the Lord gave that to Perkins.

"All you need to tell him is that a certain thing ought to be done. He goes and does it. It isn't mentality nor suavity nor talent. I don't know what it is. He doesn't know. But when he puts his shoulder to a wheel it moves. When he faces obstacles they vanish."

"I see," said the young man, "a sort of typical American, crude but efficient."

"Yep," replied his uncle. "You've said it. Still, he doesn't do things, you know. He gets things done. There's a difference."

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Lakeside Plant Visited by A. S. M. E.

AT THE invitation of the Milwaukee Electric Railway & Light Co., 125 members and guests of the American Society of Mechanical Engineers visited the Lakeside plant of that company on Friday, May 27, as the closing event of the Spring Meeting held in Chicago. This power plant is the first large central station in this section of the country designed and built with the intention of using powdered coal only as fuel, and therefore represents quite a departure in the power plant field. Thorough investigations in regard to the preparation and burning of pulverized coal are being carried on in this plant and it is to be hoped that when these have been completed, engineers will have more definite operating data upon which they can base future power plant developments.

Upon reaching the plant, the engineers were assembled and given a short talk, illustrated with lantern slides, by John Anderson, the engineer of the company responsible for the design, construction and operation of the plant, after which they were shown about the plant and given an opportunity to ask questions relative to the engineering problems involved.

It was stated that the engineering work on this plant was started in February, 1920, and on Dec. 15, 1920, the plant was generating 20,000 kw., which is the capacity of one generator, two of which are now installed, the ultimate capacity of the plant as designed being 200,000 kw.

Each of the eight boilers now installed has a heating surface of 13,060 sq. ft., these being 21-ft. Edge Moor water-tube boilers with four baffles, which results in higher gas velocities over the tubes than with three baffles, cleaner tubes and better heat transfer.

The coal is prepared in a building entirely separate from the power house proper erected at a cost of $350,000, which is considered higher than would ordinarily be necessary owing to local conditions. The equipment installed for preparing the coal cost $255,000 and has a capacity sufficient to care for the needs of an 80,000 kw. power plant. For pulverizing the coal 2½ per cent is used for auxiliary purposes, and the cost of maintenance to date has been 5 cents per ton, but it is anticipated that this will average 10 cents per ton in the long run.

Coal comes to the plant by rail either direct from the mines or from storage a half mile distant. Two methods are provided for dumping the coal; one is the originary track hopper for use with bottom dump cars; the other dumps the car by rolling it over, the operation taking about 50 sec.

From the track hopper the coal passes through a series of two crushers; the first breaks up the large lumps and is provided with a bypass for the fine coal; the second is a hammer-mill crusher and delivers to a conveying belt 300 ft. long with a rise of 90 ft. which is normally operated at a speed of 350 ft. per minute.

This belt delivers the coal to a system of conveyors in the pulverizing building where it is automatically weighed and then passed through the driers. With the Illinois coal which is used, satisfactory results have been secured when the moisture in the coal pulverized does not exceed 6 per cent. It has been the practice in other plants, however, to reduce the moisture to 1 per cent before pulverizing. There seems to be no doubt but that the quality of the coal governs largely the percentage of dryness required.

From the driers the coal is delivered to the pulverizers by screw conveyors and here reduced to such fineness that 67 per cent will pass through a 200-mesh screen. This is also a variation from former practice which calls for 85 per cent through a 200-mesh screen. Here again the quality of the coal is without doubt a governing factor.

Leaving the pulverizers the powdered coal is carried to the boiler house hoppers by a current of compressed air in pipes. These hoppers are airtight tanks vented through the roof by a pipe. From them the coal flows like water to the burners and is controlled by valves.

Four burners are provided for each boiler, the eight furnaces being tended by two firemen. Air supply for combustion is drawn through spaces around the furnace lining, thus reducing radiation and bringing the temperature of the air up to 500 deg. as it enters the furnace. The volume of each furnace is 7200 cu. ft.

Ashes falling to the bottom of the furnace are cooled by contact with floor but with this arrangement alone difficulty is experienced in preventing slag formation when the boilers are operated at high ratings and to overcome this difficulty one of the boilers has been equipped with a water grate which cools the lower part of the furnace and prevents slag. The ash accumulation is removed by means of a steam jet ash conveyor. The statement was made, however, that considerable ash collects in the gas passages from the boiler and a portion is discharged out through the stack. The unburned carbon in this dust runs about 1 per cent.

Flue gas analyses show an average, as graphically recorded by an instrument, of about 14½ per cent CO_2 and with the boiler operated at 235 per cent rating, the temperature of the flue gas leaving the boiler is 490 deg., and leaving the economizer at 210 deg. Although the boilers are designed for 300 lb. steam pressure, they are operated at 265 lb. and 200 deg. superheat.

Under test conditions, an efficiency of 85.6 per cent has been secured from the boiler alone and considering boiler and economizer 90.2 per cent efficiency has been obtained. These figures do not include the steam used by auxiliaries.

An interesting demonstration was given for the benefit of the visitors who watched the steam flow meter on one boiler when the fuel supply was cut off and the load gradually was reduced to less than 500 hp.; then the fuel feed was again started and the load brought up to 2300 hp. in a few seconds less than 2 min., showing the ability of this equipment to handle flexible loads.

In the turbine room are two 20,000-kw. generating units, delivering three-phase currents at 13,000 v. The vacuum maintained in the surface condensers serving these turbines is 28 in., the cooling water being supplied from the lake through a 10-ft. tunnel 700 ft. long with the traveling screens, two of which are now installed, located in the basement of the turbine room. To insure a continuous and unlimited supply of cooling water, a rubble wall of rocks was built, blocking off a large pond in the lake. This wall protects the openings to the tunnels from ice blocks, sand and fish.

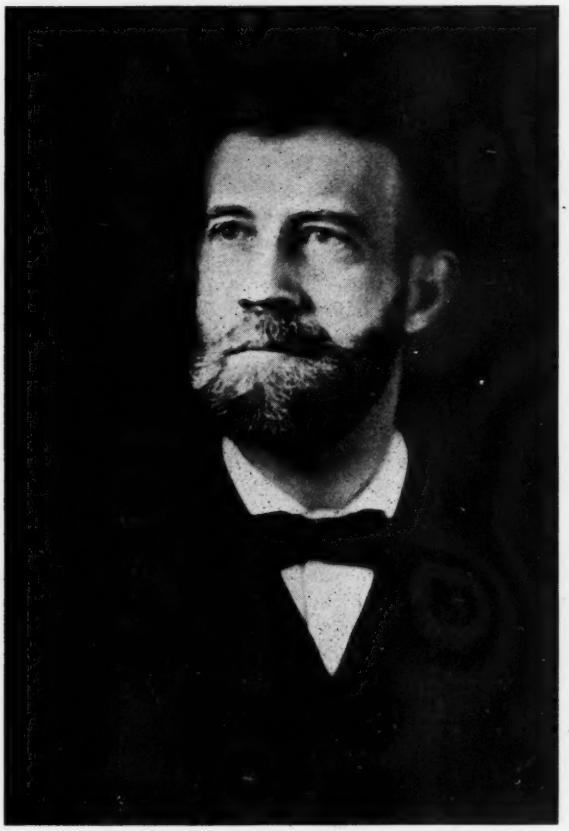
Freedom from dust was one of the notable features of the plant; even in the pulverizing house the atmos-

phere was perfectly clear and hand rails, pipes, ledges, etc., were free from dust.

Without question this plant marks a great stride forward in the use of powdered coal in power plants and its success will be watched with the utmost interest.

G. J. Foran

GEORGE JESSE FORAN was born in Boston, Mass., on Jan. 22, 1862, the son of George W. and Mary (Crane) Foran. He was educated in the Boston schools and in the Wesleyan Academy at Wilbraham, Mass., and was graduated from the Massachusetts Institute of Technology in May, 1883, in the Department of Mechanical Engineering, with the degree



GEORGE J. FORAN

of Bachelor of Science. His graduation thesis was a history of the art and design of pumping machinery. of which he had made a special study during the previous year.

On Sept. 1, 1883, Mr. Foran entered the employ of the Deane Steam Pump Co., Holyoke, Mass., and, after a few months of preparatory shop experience, was transferred to the Boston office of that company.

On Nov. 9, 1886, he became connected with the George F. Balke Manufacturing Co., where he served as salesman in the engineering field for some years, later acting also as consulting engineer to the president and treasurer of the Blake Company, with special attention to engineering design and construction of water works, condensing and air compressor installations, tests and investigations in New England.

Upon the completion of the new Blake Works at East Cambridge, Mass., he became office manager, which post he occupied from 1890 to 1897 and was also the head of the estimating and cost department, during which time he inaugurated the cost system which was then installed. He later returned to the engineering sales department.

The companies above mentioned were part of the companies which, in 1901, consolidated in the formation of the International Steam Pump Co. When that organization was effected Mr. Foran moved to New York as manager and chief engineer of the condenser department of Henry R. Worthington and the associated companies of the International Steam Pump Co. He continued to fill that position ably with the Worthington Pump & Machinery Corp., which succeeded to the International Steam Pump Co. He was active in the design of high vacuum apparatus during the entire development of that class of machinery. He was the head of the department at the time of his death, on May 12, 1921.

During the war, Mr. Foran served upon the committees for condensing apparatus of the United States Shipping Board and War Industries Board and as chairman of the American Engineering Service of the Engineering Council which dealt with all questions of personnel between the various departments of the United States Government and the four National Engineering Societies. He was chairman of the condenser and heater section of the Power Test Codes Committee of the American Society of Mechanical Engineers, of which society he became a member in 1887.

Mr. Foran married Emma M. Snelling, of Boston, in 1888.

News Notes

THE 44TH convention of the National Electric Light Association, held in Chicago, May 31 to June 3, proved to be one of the largest and most successful ever held by that association. A broad and diversified program brought over three thousand delegates and their friends from every section of the country.

At the various sessions of the National sections, light and power company executives, manufacturers, government experts and engineers all pledged their co-operation in working out the problems of the association for the coming year.

On Friday, June 3, the last day of the meeting, the officers of the National Executive Committee were elected. Milan R. Bump, chief engineer for Henry L. Doherty & Co. of New York was elected president. Mr. Bump succeeds Martin J. Insull, vice-president of the Middle West Utilities Co. of Chicago.

Other officers elected are: First vice-president, Frank W. Smith, United Electric Light & Power Co. of New York; second vice-president, Walter H. Johnson, Philadelphia Electric Co.; third vice-president, Franklin T. Griffith, Portland Railway, Light & Power Co., Portland, Ore.; fourth vice-president, J. E. Davidson, Nebraska Power Co., Omaha; treasurer, H. C. Abell, American Light & Traction Co., New York. Atlantic City probably will be selected as the meeting place for the 1922 convention. The Chamber of Commerce of that city has extended an invitation, but the national executive committee will decide this question later.

DEXTER S. KIMBALL, dean of the College of Engineering of Cornell University, was nominated president of the American Society of Mechanical Engineers in the report of the nominating committee for 1921 submitted to the society's council on Tuesday, May 24, at the spring meeting of the society held in Chicago, May 23 to 26.

Three vice-presidents were also nominated. They are: Col. E. A. Deeds, of Dayton, Ohio; Robert Sibley, of San Francisco; and L. E. Strothman, of Milwaukee. Sherwood F. Jeter of Hartford, Horace P. Liversidge of Philadelphia, and Hollis P. Porter of Tulsa, Okla., have been nominated as managers in addition to W. S. Finlay, Jr., of New York, who was nominated to fill the unexpired term of Mr. Kimball.

William H. Wiley of New York City has again been nominated as treasurer. He has occupied this office, having been regularly nominated and elected each year, since 1884.

Francis Blossom, of New York; Charles A. Booth, of Buffalo; Gano Dunn, of New York; H. H. Esselstyn, of Detroit; W. S. Lee, of Charlotte, N. C.; Irving E. Moultrop, of Boston; John A. Stevens, of Lowell, Mass.; A. E. Walden, of Baltimore, and Perley F. Walker, of Lawrence, Kan., have been nominated to represent the society on the board of the Federated American Engineering Societies.

IN THE ANNUAL election of the Denver section of the American Institute of Electrical Engineers, the following were elected: Burton C. J. Wheatlake, manager of the supply department of the General Electric Co., chairman; Edward A. Phinney, vice-president and general manager of the Jefferson County Power & Light Co., vice-chairman; and Robert B. Bonney, educational director of the Mountain States Telephone & Telegraph Co., was named as secretary-treasurer.

Professor L. D. Crain, of the department of mechanical engineering at the Colorado Agricultural College, entertained the members with a timely discourse, "Electricity on the Farm."

THE C. H. WHEELER MANUFACTURING CO., of Philadelphia, on June 1 opened a new branch office in Boston, to be located at 53 State St., Room 613.

COMBUSTION ENGINEERING CORPORATION has increased its sales organization and established a new service department in the Philadelphia district. This change has necessitated an increase in office space and the new location is in the Finance Building.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO. announces the opening of a service department and repair shop at 1535 Sixth St., Detroit, Mich., to install or repair electrical or steam apparatus either in the shop or in the field.

THE M. J. DOUGHERTY CO., Philadelphia, announces a change of address of its Atlanta representative's office address to Candler Annex. This office is in charge of Messrs. McKee and Wright. Their territory takes in the states of Florida, Georgia, Alabama, Tennessee, North Carolina and South Carolina.

ON JUNE 1, L. L. Wilkinson, district sales manager of The Ohio Brass Co., opened an office at 710 Witherspoon Building, Philadelphia. Formerly Mr. Wilkinson, together with J. O. Patrick, were sales representatives in the East, making their headquarters at 50 Church St., New York City. Mr. Patrick will remain at the New York office.

THE HAUCK MFG. CO., Brooklyn, N. Y., has elected its president, Henry T. Gerdes, mechanical engineer and manufacturer of New York; first vice-president, M. C. Hauck; second vice-president, A. B. Hauck; third vice-president, H. H. Kress; treasurer, A. H. Stein; secretary, J. Lutz.

Mr. Gerdes, who succeeds the late Arthur E. Hauck, is a graduate of Stevens Institute of Technology and was for many years manager of the Treadwell Engineering Co., of Easton, Pa.

Trade News

OHIO BRASS CO.'s Catalog No. 52 comprises 94 pages on the company's gate, globe, angle and check valves, lock-shield valves, gas service, composition discs, radiator valves and union elbows.

OIL BURNERS and combination oil and gas burners made by The George J. Hagan Co., of Pittsburgh, Pa., are the subject of an illustrated bulletin, L. F. 102, from that company.

BULLETINS have been received from Defender Automatic Regulator Co., St. Louis, Mo., as follows: No. 90, on Defender draft gages for natural draft; No. 95, on Defender Model C draft gages for boilers using forced draft, underfeed stokers or pulverized coal.

POWER TURBO-BLOWER CO. has recently issued catalog 21, describing power and simplex turbo-blowers and turbines. The introductory part of the catalog deals in a concise manner with such topics as complete combustion, elimination of smoke, getting the most out of your coal, changing power conditions, chimney draft, etc. The remainder of the catalog is given over to descriptions and illustrations of details of construction, instructions for installation and views of turbo-blowers in modern power plants.

SPRAGUE ELECTRIC Hoists, described in Bulletin No. 48,967 of Sprague Electric Works of General Electric Co., are built in capacities of from ¼ to 6 t., to be used in places where it would be difficult or impossible to install electric cranes. The bulletin illustrates typical installations of the hoists, which are of two general types: worm geared hoists and spur geared hoists, for both direct current and polyphase alternating current circuits.

POWER PLANT PIPING is the title of a catalog recently issued by the M. W. Kellogg Co., which discusses problems that have been met with in designing piping layouts and how they have been met. Considerable space is devoted to descriptions and discussions of the relative merits of various types of pipes and fittings. A table of the properties of saturated and superheated steam up to 600 lb. pressure and 600 deg. superheat is included. A section is devoted to hydraulics, equations for flow, and a table gives loss of head due to friction.